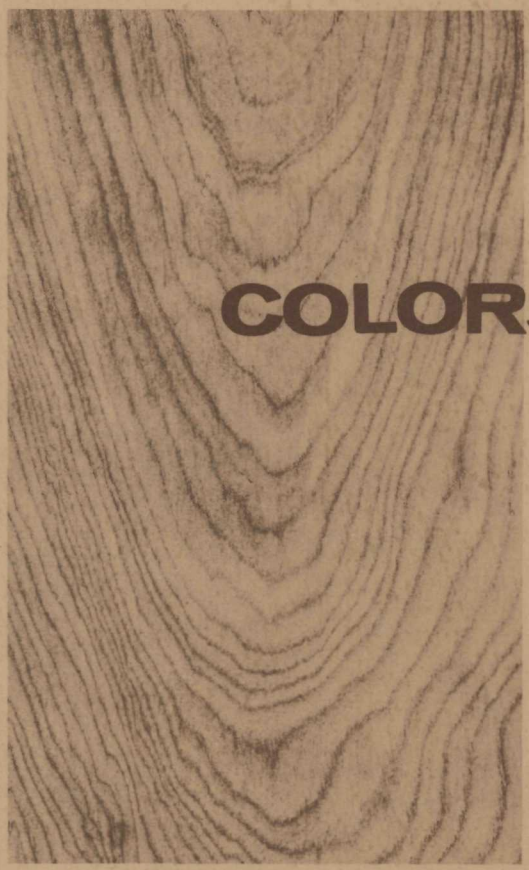
# WOOD...



## COLORS AND KINDS

Agricultural Handbook No. 101

UNITED STATES DEPARTMENT OF AGRICULTURE

Forest Service

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ROGER B. RUSSELL and Donovan R. Every of the Forest Products Laboratory photographic staff made the full-color photographs in this publication. B. Francis Kukachka, in charge of wood identification, selected the species and prepared the descriptive text in collaboration with Douglas A. Zischke and Frederick A. Strenge of the publications staff.

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# WOOD: COLORS AND KINDS

**Prepared by Forest Products Laboratory, Forest Service**

A key element in any business transaction involving wood is the proper identification of species. Literally scores of different woods are bought and sold daily for hundreds of uses. A New England home may be framed with Douglas-fir from Oregon, floored with red oak from Arkansas, sided with California redwood, and trimmed inside with Michigan yellow birch. Its furniture may be veneered with Pennsylvania black cherry over Wisconsin basswood and fitted with drawers of Indiana sycamore and backs of Carolina sweetgum. It is apparent that familiarity with only locally grown species is not enough in today's lumber markets.

Often, any one of several species is suitable for a specific use. Other species, however, may be entirely unfit for that use. Of those suitable, some are better than others because they are stronger, perhaps, or more attractive, or hold paint better. Others may be superior because they are harder, shrink less, resist decay, or are more easily cut and joined. It follows, then, that correct identification is essential to insure selecting the right wood for a given job.

As the official wood identification agency of the United States Government, the Forest Products Laboratory annually receives thousands of requests for identification service from industry, other branches of the Federal Government, units of State and local governments, and the general public. This service is requested in connection with business transactions, civil lawsuits, criminal cases, building codes for homes and other structures, industrial standards, and Government purchase specifications. The Laboratory has also been called upon to identify wood from tombs of Egyptian Pharaohs, sunken pirate ships, prehistoric forests, and the beam that supports the Liberty Bell.

In the great majority of day-to-day transactions, however, wood identification is a relatively simple problem. By acquiring a little know-how, many lumbermen, dealers, builders, manufacturers, consumers, students, and home-workshop hobbyists could solve their identification problems on the spot. Consequently, this publication was prepared as an aid to those persons concerned with identifying the more common native species of wood.

Characteristics that are apparent to the naked eye and that distinguish our native woods from each other are described for each of 32 species. Because color is an important identifying characteristic of many woods, special attention has been paid to describing the natural color of a freshly cut surface of the wood.

Descriptions of species are accompanied by full-color illustrations showing grain pattern and other characteristics. Beginning at the top of the illustration, **end-grained, edge-grained** (quartersawed), and **flat-grained** (plainsawed) surfaces are all displayed. This is done because certain identifying characteristics show up best on each surface. The terms "edge-grained" and "flat-grained" are used in reference to softwood lumber, while quartersawed and plainsawed refer to hardwood lumber.

The manner in which it is sawed from the log will, of course, determine whether a piece of wood shows flat-grained or edge-grained patterns of annual growth rings on its wide surfaces. Lumber is manufactured in both forms.

Each color plate presents two species. Where possible, closely similar species are shown together on one plate, so that distinguishing characteristics can be more conveniently examined. In other cases, species are paired on one plate because they are often marketed in mixture or used interchangeably.

Certain species are not distinguishable from close relatives by the wood alone, even under the microscope. Thus, for example, the wood of many different species of red oak is identical in structure and appearance even though the trees from which it comes may differ markedly in leaf, bark, and fruit. From the wood user's standpoint, however, botanical differences in trees usually do not matter so long as their wood is consistent in properties and appearance. Where appropriate in the descriptions, differences are mentioned that distinguish a species from closely similar ones not shown. The general range of growth, properties, and common uses of each species are also given.

Obviously, many other species could have been included with the 18 hardwoods and 14 softwoods described in this publication. Those chosen are the species most commonly found in retail lumber markets.

To assist the reader in getting the utmost help from this booklet, the terms used in the descriptions are defined in a glossary. These terms are in common use among wood technologists, and the features of wood to which they apply are regularly used for identification and other purposes at the Forest Products Laboratory. The common and botanical names of species conform to the official Forest Service nomenclature for trees. Cubic-foot weights of species described are averages taken at 12 percent moisture content; specific gravity is based on volume when green and weight when ovendry.

For information on botanical differences among species, such as the shape of leaves, patterns of bark, and form of fruit, the reader is referred to Trees, the 1949 Yearbook of the U. S. Department of Agriculture.

# HARDWOODS (Broad-Leaved Species)

## American beech (*Fagus grandifolia*)

**Range.**—The natural range of beech in the United States extends from Maine to northern Florida and westward from the Atlantic coast into Wisconsin, Missouri, and Texas. It usually grows in mixture with other species, although pure stands of considerable extent occur in the Blue Ridge Mountains, especially in North Carolina.

**Properties.**—One of the heavy woods, American beech has an average weight of 45 pounds a cubic foot and, with a specific gravity of 0.56, is classified as hard. It is rated high in strength and shock resistance and is readily bent when steamed.

Beech is subject to very large shrinkage and requires considerable care during seasoning if checks, warp, and discoloration are to be avoided. Heartwood ranks low in resistance to decay. The wood wears well and stays smooth when subjected to friction, even under water. Although ranking high in nail-withdrawal resistance, it has a tendency to split when nails are driven into it. When pulped by the soda process, beech yields a short-fibered pulp that can be mixed with longer fibered pulps to obtain paper of satisfactory strength.

**Uses.**—American beech is used for lumber, distilled products, veneer, railroad ties, pulpwood, cooperage, and fuel. The lumber is used largely in the manufacture of boxes, crates, baskets, furniture, handles, flooring, woodenware, general millwork, and novelties. Beech is especially suitable for food containers, since it does not impart taste or odor.

**Description.**—Heartwood is white with a reddish tinge to reddish brown. Pores are not visible but wood rays can be seen on all surfaces. On the end grain, the rays appear to be irregularly spaced, while on quartersawed surfaces they appear to be of different heights along the grain. On the plainsawed surfaces, the rays also appear to be of different height, but they look much narrower in this view. Beech is readily distinguishable from other native species by its weight, conspicuous rays, and tiny pores. (*Illustration, p. 11.*)

## American sycamore (*Platanus occidentalis*)

**Range.**—American sycamore grows in scattered groups or singly from southern Maine westward to Nebraska and southward to eastern Texas and northern Florida. It grows best on flatlands where there is a good supply of ground water and along the edges of streams, lakes, and swamps. At least half of the stand of American sycamore is in the central and southern portions of its range in Alabama, Arkansas, Indiana, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee.

**Properties.**—In weight, American sycamore is ranked as a moderately heavy wood, averaging 34 pounds a cubic foot. A moderately hard wood, with a specific gravity of 0.46, it has a close texture and an interlocking grain. It is moderately strong, moderately stiff, and has moderately good shock resistance.

Sycamore has large shrinkage while drying, is inclined to warp, and is somewhat difficult to season. Also, it is not durable when exposed to conditions favorable to decay. The wood turns well on a lathe and keeps its shape well when bent to form after steaming. It is only intermediate in nail-withdrawal resistance but because of its interlocking grain ranks high in its ability to withstand splitting. Sycamore wood does not impart taste, odor, or stain to substances that come in contact with it.

**Uses.**—The principal uses of American sycamore are for lumber, veneer, railroad ties, cooperage, fence posts, and fuel. The lumber goes largely into furniture and boxes. Considerable sycamore veneer is used for fruit and vegetable baskets and berry boxes. Although generally used for the cheaper grades of furniture, sycamore is used in one form or another in practically all grades. Other products made from the lumber include flooring, scientific instruments, handles, and butchers' blocks.

**Description.**—Heartwood is reddish brown or flesh brown in color. Pores are very small and not visible to the unaided eye. Rays are visible on all surfaces. They appear uniformly spaced on the end grain and of uniform height on quartersawed surfaces. Plainsawed surfaces show rays that appear more numerous and more closely spaced than in beech. (*Illustration, p. 11.*)

## Rock elm (*Ulmus thomasii*)

**Range.**—Rock elm grows from New Hampshire to Nebraska and as far south as Tennessee. Much of the commercially important rock elm is located in Wisconsin and Michigan and more than 80 percent of rock elm lumber and veneer comes from these 2 States.

**Properties.**—Rock elm is a heavy wood, averaging 44 pounds a cubic foot. The wood is classified as hard, with a specific gravity of 0.57. It is stronger, harder, and stiffer than any of the other commercial elms. With the exception of hickory and dogwood, rock elm has higher shock resistance than any other American hardwood.

Although rock elm undergoes large shrinkage when drying, it tends to shrink somewhat less than the other commercial elms. As with all the elms, care must be taken to prevent warp during seasoning. Rock elm is somewhat difficult to work with hand or machine tools, and the heartwood has low to moderate resistance to decay. However, all the commercial elms have excellent bending qualities.

**Uses.**—Elm lumber is used principally for containers and furniture. In some cases, the different species of elm are employed indiscriminately, but when hardness or shock resistance is required to a high degree, rock elm is preferred. Rock elm veneer is used in considerable quantities in manufacturing various types of containers, especially fruit and vegetable boxes and baskets.

Large quantities of rock elm also go into crating for heavy articles, such as furniture, glass, and porcelain. The strength and toughness of this wood make it very serviceable for certain types of containers that must stand rough usage, such as market baskets and bushel baskets for home use. Considerable quantities are used in the manufacture of furniture, especially the bent parts of chairs.

**Description.**—Heartwood is brown to dark brown, sometimes with shades of red. Summerwood pores are arranged in concentric wavy lines that appear lighter than the background wood. The springwood pores in rock elm are visible only upon magnification. (*Illustration, p. 12.*)

## American elm (*Ulmus americana*)

**Range.**—American elm grows throughout the eastern United States except in the Appalachian highlands and southern Florida. About three-fourths of the stand of sawtimber size is located in the Lake States and the Mississippi Delta region. Wisconsin, Michigan, Louisiana, Arkansas, Ohio, and Indiana have large volumes of elm.

**Properties.**—American elm is moderately heavy, averaging 35 pounds a cubic foot, and moderately hard, with a specific gravity of 0.46. It rates as moderately weak, but is moderately stiff and has good shock resistance.

The wood of American elm has large shrinkage and care must be taken to prevent warping as it seasons. Like all of the commercial elms, it has excellent bending qualities. Its heartwood has low to moderate resistance to decay. The wood is slightly below average in woodworking properties, but is among the top woods in ease of gluing. In nail-withdrawal resistance, it has an intermediate rank.

**Uses.**—American elm lumber is used principally in the manufacture of containers, furniture, and dairy and poultry supplies. Because of its excellent bending properties, the wood has been much used for barrels and kegs. Considerable quantities of veneer go into the manufacture of fruit and vegetable boxes and baskets. American elm also is used a great deal for crating heavy articles, such as furniture, glass, and porcelain products. It is used in sizable quantities in the furniture industry, particularly for the bent parts of chairs.

**Description.**—Heartwood is brown to dark brown, sometimes containing shades of red. Although the summerwood pores are not visible as individuals, they are arranged in concentric wavy lines within the boundaries of the growth rings. The wavy lines appear lighter than the background wood. American elm shows a springwood pore zone with a single row of large and easily visible pores. (*Illustration, p. 12.*)

## Black walnut (*Juglans nigra*)

**Range.**—Black walnut grows naturally over a large area extending from Vermont westward to Nebraska and southward to southern Georgia and southern Texas. The area of greatest commercial production is limited to the central part of this natural range.

**Properties.**—Black walnut is classified as a heavy wood, averaging 38 pounds a cubic foot. The wood is hard, with a specific gravity of 0.51, is strong and stiff, and has good shock resistance.

Even under conditions favorable to decay, black walnut heartwood is one of our most durable woods. It can be satisfactorily kiln-dried or air-dried, and holds its shape well after seasoning. Black walnut works easily with handtools and has excellent machining properties. The wood finishes beautifully with a handsome grain pattern. It takes and holds paints and stains exceptionally well, can be readily polished, and can be satisfactorily glued.

**Uses.**—The outstanding use of black walnut is for furniture. Large amounts are also used for gunstocks and interior finish, while smaller quantities go into railroad ties, fence posts, and fuelwood. In the furniture industry, it is used either as solid wood cut from lumber or as veneer and plywood. It also is extremely popular for interior finish wherever striking effects are desired. The wood of black walnut is particularly suitable for gunstocks because of its ability to stay in shape after seasoning, its fine machining properties, and its uniformity of texture.

**Description.**—Heartwood is chocolate brown and occasionally has darker, sometimes purplish, streaks. Unless bleached or otherwise modified, black walnut is not easily confused with any other native species. Pores are barely visible on the end grain but are quite easily seen as darker streaks or grooves on longitudinal surfaces. Arrangement of pores is similar to that in the hickories and persimmon, but the pores are smaller in size. (*Illustration, p. 13.*)

## Black cherry (*Prunus serotina*)

**Range.**—Black cherry's natural growth range is throughout Maine westward to eastern North Dakota and southward to central areas of Florida and Texas. It also occurs in the mountain ranges of western Texas. The largest supplies of black cherry are believed to be located in the Appalachian Mountains in New York, Pennsylvania, and West Virginia.

**Properties.**—Black cherry is a moderately heavy wood with an average weight of 35 pounds a cubic foot. The wood is also moderately hard, with a specific gravity of 0.47. Stiff and strong, it ranks high in resistance to shock.

Although it has moderately large shrinkage, black cherry stays in place well after seasoning and is comparatively free from checking and warping. It has moderate resistance to decay. The wood is difficult to work with handtools but ranks high in bending strength. It can be glued satisfactorily with moderate care.

**Uses.**—Nearly all the black cherry cut is sawed into lumber for various products. Much goes into furniture and considerable amounts are used for backing blocks on which electrotype plates, used in printing, are mounted. Other uses include burial caskets, woodenware and novelties, patterns and flasks for metalworking, plumbers' woodwork, and finish in buildings and railway coaches.

**Description.**—Black cherry, which is not easily confused with other native species because of its distinctive color, has light to dark reddish brown heartwood. Although individual pores are not visible to the naked eye, their pattern is sometimes distinctive. On end-grain surfaces, the pores may appear to form lines that parallel the growth rings, while on plainsawed surfaces, they may follow the outline of the growth-ring boundary.

The wood rays of cherry are barely visible on end-grain surfaces and tend to produce a distinctive flake pattern on true quartersawed surfaces. They are higher along the grain than those of walnut and hence show more prominently on quartersawed surfaces. (*Illustration, p. 13.*)

## Hickory (*Carya*)

**Species names.**—True hickories: shagbark hickory (*Carya ovata*), shellbark hickory (*C. laciniosa*), pignut hickory (*C. glabra*), and mockernut hickory (*C. tomentosa*).

**Range.**—The true hickories grow throughout most of the eastern United States except in northern New England, the northern portions of Michigan and Wisconsin, and southern Florida. Close to 40 percent of the total stand of true hickory is located in the lower Mississippi Valley region.

**Properties.**—The wood of the true hickories is very heavy, averaging from 42 to 52 pounds per cubic foot, and very hard, with a specific gravity ranging from 0.56 to 0.66. It also is very strong as a post or beam, very stiff, and exceedingly high in shock resistance. Some woods are stronger than hickory and others are harder, but the combination of strength, toughness, hardness, and stiffness possessed by hickory has not been found to the same degree in any other commercial wood.

Hickory has very large shrinkage and must be carefully dried to avoid checking, warping, and other seasoning defects. It has low decay resistance but can be glued satisfactorily.

**Uses.**—Nearly 80 percent of the true hickory used in the manufacture of wood products goes into tool handles, for which its hardness, toughness, stiffness, and strength make it especially suitable. Other uses include agricultural implements, athletic goods, and lawn furniture.

**Description.**—Heartwood is brown to reddish brown. Pores are visible, but the zone of large pores is not sharply outlined as in oak and ash. Pores grade in size from one side of the annual ring to the other. Wood rays are very small and seen without magnification only on quartersawed surfaces. Tyloses frequently plug the pores, making their outlines indistinct. Under magnification, the end grain shows numerous white lines paralleling the growth ring. (*Illustration, p. 14.*)

## White ash (*Fraxinus americana*)

**Range.**—White ash grows throughout the entire eastern half of the United States except along the Atlantic Coastal Plain, the gulf coast, and Florida. It is cut commercially everywhere except in the extreme outer limits of this range and the lower Mississippi Valley.

**Properties.**—White ash is a heavy wood with an average weight of 42 pounds a cubic foot. Ranked as a hard wood, it has a specific gravity of 0.55. It also is classified as strong and stiff, and has good shock resistance.

The wood of white ash is noted for its excellent bending qualities. In ease of working, tendency to split, and ability to hold nails and screws, it has moderately high rank. White ash lumber can be rapidly and satisfactorily kiln-dried, and it holds its shape well even under the action of water. The wood remains smooth under continual rubbing but is low in decay resistance.

**Uses.**—The use of white ash that dwarfs all others is its utilization for handles. It is the standard wood for D-handles for shovels and spades and for long handles for forks, hoes, rakes, and shovels. The wood is used too in the manufacture of furniture, where it is especially valuable for the bent parts of chairs. Its good bending qualities also make it useful for cooperage. White ash is used almost exclusively for many types of sports and athletic equipment, such as long oars and baseball bats.

**Description.**—Heartwood is brown to dark brown, sometimes with a reddish tint. As in black ash, the zone of large pores is visible and usually sharply defined. The white dots or lines that indicate summerwood pores are usually more prominent in white than in black ash. The small wood rays are generally visible only on quartersawed surfaces.

White ash is sometimes confused with hickory, but the two species are readily distinguishable. The zone of large pores is more distinctive in ash than in hickory. Also, the summerwood zone in ash shows white dots or lines that are visible to the unaided eye, but in hickory these dots or lines are visible only upon magnification. (*Illustration, p. 14.*)

## Quaking aspen (*Populus tremuloides*)

**Range.**—Quaking aspen grows throughout most of the northeastern and western United States. The eastern part of its range extends from Maine southward to Tennessee and westward to the Dakotas. It is also found throughout the western United States except in the extreme Southwest. Commercial stands of aspen are located principally in the Lake States and the Northeast, with smaller amounts in the central Rocky Mountain region.

**Properties.**—One of the lightweight hardwoods, quaking aspen averages 26 pounds a cubic foot. The wood is classified as soft, with a specific gravity of 0.35, and is weak, limber, and moderately low in shock resistance.

Although aspen has moderately large shrinkage, it can be seasoned satisfactorily by air-drying or kiln-drying. In fact, few of the hardwoods shrink as little as aspen. The wood ranks low in decay resistance. It also is low in nail-withdrawal resistance, but has little tendency to split under the action of nails or screws. It is worked easily with hand or power tools and is fairly easy to finish to a smooth surface. Aspen glues easily with a variety of glues and under a wide range of gluing conditions. In painting properties, it ranks with the best of the hardwoods.

**Uses.**—Aspen is used principally for lumber, paper pulp, excelsior, and matches. The largest present-day use of the lumber is for boxes and crates. It is probably most heavily used for pulpwood, chiefly in the manufacture of book and magazine paper and corrugating and insulating boards. Aspen has long been one of the preferred woods for the manufacture of high-grade excelsior.

**Description.**—Heartwood is white to very light brown, with occasional brown streaks associated with defects. Pores are very small and generally not visible to the unaided eye. Growth rings are usually faint. Wood rays are small, uniform in height along the grain, and visible only on quartersawed surfaces. Aspen is similar to cottonwood, but cottonwood tends to have barely visible pores. The growth rings in aspen are generally narrower than those in cottonwood. (*Illustration, p. 15.*)

## American basswood (*Tilia americana*)

**Range.**—Basswood grows throughout the eastern half of the United States from Maine westward to North Dakota and southward to Florida and eastern Texas. More than half of the total stand is located in the Lake States, and another quarter is in the east central part of the range.

**Properties.**—Basswood is a lightweight hardwood with an average weight of 26 pounds a cubic foot. The wood is weak, moderately stiff, and low in resistance to shock. Its specific gravity of 0.32 classes it as soft.

Although it has large shrinkage, basswood is fairly easy to air-dry or kiln-dry and stays in place well after seasoning. It has low nail-withdrawal resistance, but well resists splitting while being nailed. In decay resistance, it is low. The wood is easy to work with tools, takes and holds paint well, and is easily glued. When pulped by the soda process, basswood yields a soft, short-fibered, easily bleached pulp.

**Uses.**—Most of the basswood cut in this country is first made into lumber for a variety of items. The largest amounts are used for crates and boxes. The manufacture of sash, doors, and general millwork also accounts for much of the basswood lumber produced each year. In addition considerable lumber and veneer is used in the furniture industry, especially as core material overlaid with high-grade furniture veneers, such as walnut and mahogany.

**Description.**—Heartwood is creamy white to creamy brown or sometimes reddish. Pores are very small, as in aspen, and growth rings on plainsawed surfaces are generally faint. Wood rays are broader and higher than in aspen, and the two species can be readily distinguished by comparing their quartersawed faces. While the rays of aspen are low and uniform in height, some of those in basswood are distinctly higher than others and frequently darker than the background wood. (*Illustration, p. 15.*)

## Sweetgum (*Liquidambar styraciflua*)

**Range.**—Sweetgum grows from southwestern Connecticut westward almost to Kansas and southward to eastern Texas and central Florida. The commercial range in the United States is confined largely to the moist lands of the lower Ohio and Mississippi Basins and to the lowlands of the southeastern coast.

**Properties.**—Sweetgum is a moderately heavy wood with an average weight of 36 pounds per cubic foot. The wood is hard, with a specific gravity of 0.46, moderately strong when used as a beam or post, moderately stiff, and has moderately high shock resistance.

Sweetgum has very large shrinkage in drying, and the sapwood and heartwood require different drying processes. The heartwood has low to moderate decay resistance. In nail-holding ability and in ability to resist splitting by nails and screws, sweetgum is rated intermediate. The heartwood requires special treatment before gluing can be done with best results.

Sweetgum ranks above average in turning, boring, and steam-bending properties but somewhat below average in the other machining properties. Its heartwood can be finished in a wide variety of color effects and the sapwood can be readily stained if a darker color is desired.

**Uses.**—The principal uses of sweetgum are for lumber, veneer, plywood, and slack cooperage. The lumber goes principally into boxes and crates, furniture, interior trim, and millwork. Veneer is used mainly for boxes, crates, baskets, furniture, and interior woodwork. Some sweetgum is used for crossties and fuel, and comparatively small amounts go into fencing, excelsior, and pulpwood.

**Description.**—Heartwood is reddish brown and occasionally variegated with streaks of darker color. Pores are so small that they are not visible except upon magnification. Growth rings are usually indistinct or inconspicuous. Rays are visible on quartersawed faces. (*Illustration, p. 16.*)

## Black tupelo (*Nyssa sylvatica*)

**Range.**—Black tupelo grows in all States east of the Mississippi River and as far west as central Texas in the southern part of its range. In the northern and eastern parts of its range, it grows under a wide variety of conditions ranging from swamps to dry mountainsides, but in the South it is largely confined to well-drained locations. The largest commercial cuts of black tupelo lumber are made in the Southeastern States.

**Properties.**—A moderately heavy wood, black tupelo has an average weight of 35 pounds a cubic foot. It is rated as hard, with a specific gravity of 0.46, and the heartwood is low to moderate in resistance to decay. The wood is moderately weak when used as a beam or post, moderately limber, and moderately high in ability to resist shock.

Black tupelo has large shrinkage and a tendency to warp while seasoning because of its interlocking grain. Considerable care is required in the drying process to produce straight, flat lumber. The wood generally requires special treatment before gluing to obtain the best results and it ranks below the average of 25 southern hardwoods in machining properties. In nail-withdrawal resistance and resistance to splitting under the action of nails, black tupelo has an intermediate rank. It can be readily pulped by the chemical and semichemical processes.

**Uses.**—Black tupelo is used mainly for lumber, veneer, and paper pulp, and to some extent for railway ties and cooperage. The lumber goes largely into shipping containers and furniture. Black tupelo has been used for many years in the manufacture of book and similar grades of paper.

**Description.**—Heartwood is pale to moderately dark brownish gray or dirty gray. Pores are very small, as in sweetgum. Growth rings are generally inconspicuous to moderately distinct. Rays are visible on quartersawed surfaces, but show up less prominently against the background color of the wood than the rays in sweetgum. (*Illustration, p. 16.*)

## White oak (*Quercus*)

**Species names.**—The white oak group includes white oak (*Quercus alba*), chestnut oak (*Q. prinus*), post oak (*Q. stellata*), overcup oak (*Q. lyrata*), swamp chestnut oak (*Q. michauxii*), bur oak (*Q. macrocarpa*), chinkapin oak (*Q. muehlenbergii*), swamp white oak (*Q. bicolor*), and live oak (*Q. virginiana*).

**Range.**—White oaks grow mainly in the eastern half of the United States, although some species are found as far west as eastern Oregon, Washington, and California. Commercial white oaks grow east of a line from western Minnesota to western Texas.

**Properties.**—The white oaks are heavy woods, averaging 47 pounds a cubic foot, and are very hard, with a specific gravity ranging from 0.57 in chestnut oak to 0.81 in live oak. Led by live oak, they rank high in strength properties.

The wood of the white oaks is subject to large shrinkage and seasoning must be done carefully to avoid checking and warping. Pores of the heartwood, with the exception of chestnut oak, are usually plugged with tyloses, a frothlike growth that makes the wood impervious to liquids. The heartwood itself is comparatively decay resistant, generally more so than that of the red oaks. White oaks are above average in all machining operations except shaping.

**Uses.**—Most white oak is made into lumber for flooring, furniture, general millwork, and boxes and crates. Large amounts are used for flooring and furniture and it is the outstanding wood for tight barrels, kegs, and casks because of the nonporous heartwood. It has long been the leading wood for the construction of ships and boats.

**Description.**—Heartwood is grayish brown. The outlines of the larger pores are indistinct except in chestnut oak, which has open pores with distinct outlines. On smooth-cut, end-grain surfaces, the summerwood pores are not distinct as individuals. Wood rays are generally higher than in red oak, the larger ones ranging from ½ to 5 inches in height along the grain. As in red oak, rays appear lighter in color than the background wood on end-grain surfaces and darker than the background wood on side-grain surfaces. (*Illustration, p. 17.*)

## Red oak (*Quercus*)

**Species names.**—The red oak group includes northern red oak (*Quercus rubra*), black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), shumard oak (*Q. shumardii*), pin oak (*Q. palustris*), Nuttall oak (*Q. nuttallii*), southern red oak (*Q. falcata*), water oak (*Q. nigra*), laurel oak (*Q. laurifolia*), and willow oak (*Q. phellos*).

**Range.**—Red oaks grow quite generally east of the Great Plains except for a narrow coastal strip along the Gulf of Mexico and in Florida. The largest amounts of commercial timber are cut in Tennessee, Arkansas, Kentucky, and Missouri.

**Properties.**—The red oaks are similar in many properties to the white oaks. A major difference is that red oak, because it lacks tyloses in its pores, is extremely porous. A heavy wood, it averages 44 pounds a cubic foot and the average specific gravity of the more important species ranges from 0.52 to 0.60. The wood is hard, stiff, and has high shock resistance.

Red oak undergoes large shrinkage while drying, and seasoning must be done carefully to avoid checking and warping. It is considerably above average in all machining operations except shaping, and the heartwood ranks low to moderate in decay resistance.

**Uses.**—Most of the red oak cut in this country is converted into flooring, furniture, millwork, boxes and crates, caskets and coffins, agricultural implements, boats, and woodenware. Considerable lumber is also used in building construction, and some is exported. The hardness and wearing qualities of red oak have made it an important flooring wood for residences. Preservative-treated red oak is used extensively for crossties, mine timbers, and fence posts.

**Description.**—Heartwood is grayish brown with a more or less distinctive reddish tint. Pores are commonly open, and the outlines of the larger pores are distinct. On smoothly cut end-grain surfaces, the summerwood pores can be seen as individuals and readily counted when examined with a hand lens. Wood rays are commonly ¼ to 1 inch high along the grain. On end-grain surfaces, rays appear as lines crossing the growth rings. (*Illustration, p. 17.*)

## Yellow birch (*Betula alleghaniensis*)

**Range.**—Yellow birch grows in the Lake States, New England, New York, New Jersey, Pennsylvania, and along the Appalachian Mountains into southern Georgia. It reaches its best development near the Canadian border, and more than half of the stand is located in Michigan. The largest amounts of lumber are produced in Michigan and Wisconsin.

**Properties.**—Yellow birch is heavy, averaging 43 pounds a cubic foot, and hard, with specific gravity averaging 0.55. The wood is strong, stiff, and has very high shock resistance.

Yellow birch has very large shrinkage and must be seasoned carefully to prevent checking and warping. Like all commercial birches, it is low in decay resistance. Although the wood is difficult to work with handtools, it can be readily shaped by machine and ranks high in nail-withdrawal resistance.

**Uses.**—Yellow birch is used principally for lumber, veneer, distilled products, and crossties. The lumber and veneer go mostly into furniture, boxes, baskets, crates, woodenware, interior finish, and general millwork. It is because of its pleasing grain pattern and ability to take a high polish, that yellow birch is widely used in the furniture industry. Spools, bobbins, and other turned articles are also important products.

Yellow birch is one of the principal woods used for hardwood distillation to produce wood alcohol, acetate of lime, charcoal, tar, and oils. It is used in smaller quantities for pulpwood and cooperage.

**Description.**—Yellow birch heartwood is light reddish brown. Pores are very small, sometimes just barely visible on smoothly cut end-grain surfaces, and are uniformly distributed through the annual ring cross section. Pore lines are visible on longitudinal surfaces as very fine grooves that may even be seen through natural finishes. Wood rays may be seen only on quartersawed surfaces, where they appear to be of one size and of uniform height along the grain. Growth rings are moderately distinct on plainsawed surfaces. (*Illustration, p. 18.*)

## Sugar maple (*Acer saccharum*)

**Range.**—Sugar maple grows from Maine to Minnesota and southward to eastern Texas and northern Mississippi, Alabama, and Georgia. The largest stands are in the Lake States and the Northeast. The tree grows singly or in groups in mixed stands of hardwoods.

**Properties.**—Sugar maple is heavy, averaging 44 pounds a cubic foot, and hard, with a specific gravity of 0.56. Strong and stiff, it has high resistance to shock. Although it has large shrinkage and presents some difficulties in drying, the wood can be satisfactorily seasoned. Its resistance to decay is low to moderate.

Sugar maple ranks high in nail-withdrawal resistance and intermediate in ease of gluing. The wood takes stain satisfactorily and is capable of a high polish. Although generally straight-grained, sugar maple occasionally occurs with curly, wavy, or bird's-eye grain. The wood turns well on a lathe, is markedly resistant to abrasive wear, and is without characteristic taste or odor.

**Uses.**—Sugar maple is used principally for lumber, distilled products, veneer, crossties, and paper pulp. Probably 90 percent of the lumber is manufactured into such products as flooring, furniture, boxes and crates, handles, woodenware, and novelties. It is especially suitable for bowling alleys, dance floors, and other flooring that is subjected to hard use. Sugar maple is one of the principal woods used in the hardwood distillation industry for the production of charcoal, acetic acid, and wood alcohol.

**Description.**—Heartwood is light reddish brown and sometimes shows greenish-black streaks near injuries. Pores are extremely small and not visible on any surface. Wood rays may be seen on the end grain and especially on quartersawed faces, where the higher rays are distinctive because of their color and size and smaller rays appear as fine lines between them. The wood rays may also be seen on plainsawed surfaces as very small darker colored flecks that are parallel to the grain of the wood. (*Illustration, p. 18.*)



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## Yellow-poplar (*Liriodendron tulipifera*)

**Range.**—Yellow-poplar grows in all the States east of the Mississippi River except Maine, New Hampshire, Vermont, and Wisconsin, and in parts of Oklahoma and Missouri. Virginia, North Carolina, South Carolina, Georgia, and Alabama contain more than half of the yellow-poplar sawtimber in the United States.

**Properties.**—Moderately light in weight, yellow-poplar averages 30 pounds a cubic foot. The wood is classed as moderately soft, with a specific gravity of 0.40, and is moderately low in bending and compressive strength, moderately stiff, and moderately low in shock resistance. Although it undergoes moderately large shrinkage when dried from a green condition, it is not difficult to season and stays in place well when seasoned. The heartwood is low to moderate in resistance to decay.

Yellow-poplar ranks intermediate in machining properties. Although low in nail-withdrawal resistance, it has little tendency to split when nailed. Also, the wood has an excellent reputation for taking and holding paint, enamel, and stain and can be glued satisfactorily. Yellow-poplar containers do not impart taste or odor to foodstuffs, and the wood can be easily pulped by the chemical and semichemical processes.

**Uses.**—The principal uses of yellow-poplar are for lumber, veneer, and pulpwood. The lumber goes mostly into furniture, boxes and crates, interior finish, siding, fixtures, and musical instruments. The veneer is used extensively for finish, furniture, and various forms of cabinetwork.

**Description.**—Heartwood is brownish yellow, usually with a definite greenish tinge. The wood rays, as seen on a smoothly cut end-grain surface, are somewhat more prominent than in cucumbertree. Positive identification of yellow-poplar and cucumbertree is best accomplished microscopically, but it is possible to separate them on the basis of gross features when both woods are at hand. (*Illustration, p. 19.*)

## Cottonwood (*Populus*)

**Species names.**—Eastern cottonwood (*Populus deltoides*), swamp cottonwood (*P. heterophylla*), and black cottonwood (*P. trichocarpa*).

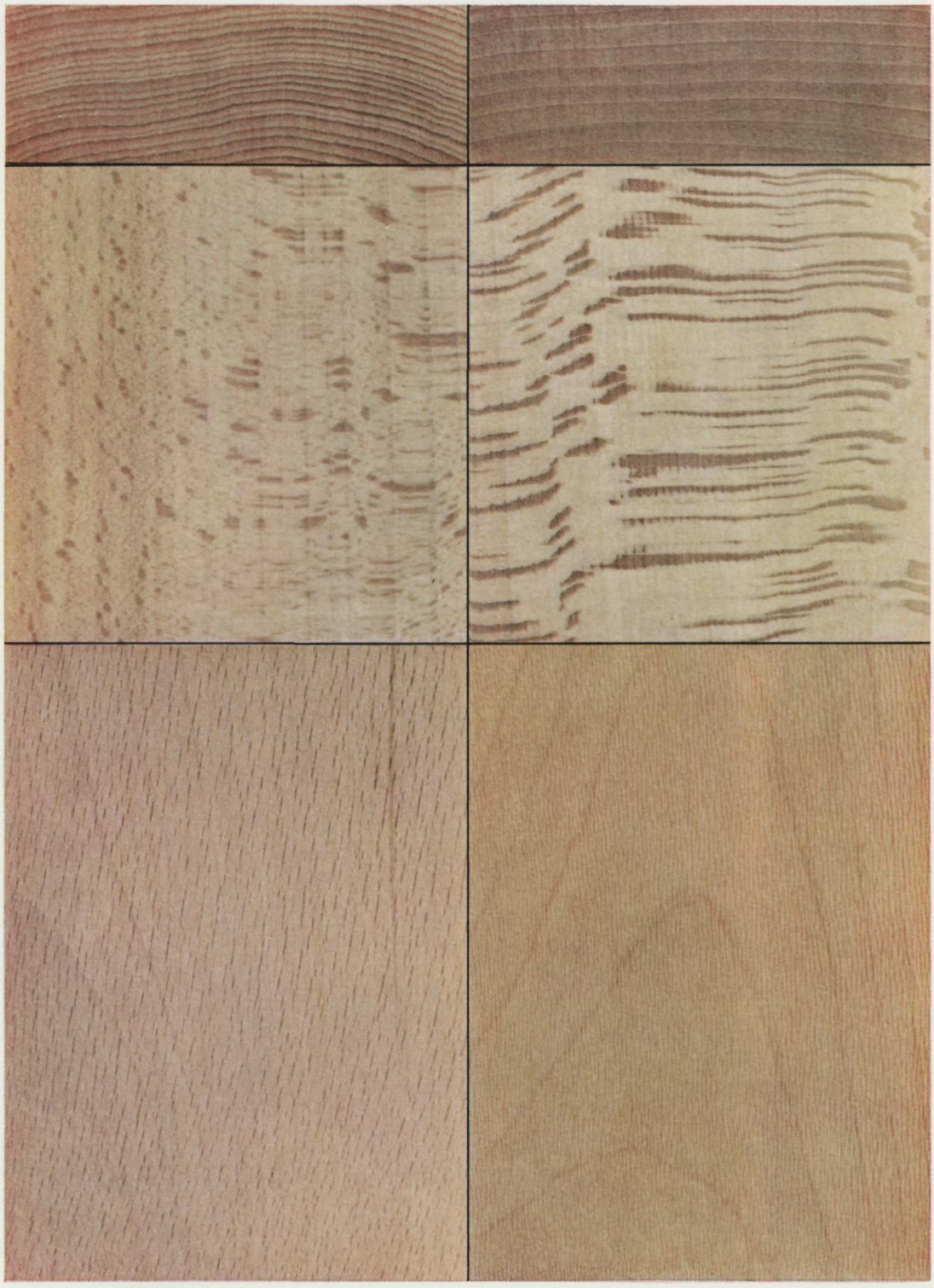
**Range.**—Eastern and swamp cottonwood grow in small scattered stands or in mixture with other species. They range from southern New England westward to the southern part of the Lake States and southward to northern Florida and eastern Texas, except in the Appalachian highlands from New York to Georgia and in the Ozark Mountains of Arkansas and Missouri. Black cottonwood grows in the Pacific Coast States and in western Montana, northern Idaho, and western Nevada.

**Properties.**—The cottonwoods are moderately light in weight, ranging from 24 to 28 pounds a cubic foot. With a specific gravity of 0.37, eastern cottonwood is classified as moderately soft, while black cottonwood's specific gravity of 0.32 classifies it as soft. The cottonwoods are moderately weak in bending and compression, moderately limber, and moderately low in shock resistance.

Moderately large shrinkage is a characteristic of cottonwood and it requires careful seasoning if warp is to be avoided. The heartwood has low decay resistance and the wood is rather difficult to work with tools without producing chipped or fuzzy grain. Cottonwood is low in nail-withdrawal resistance but does not split easily when nailed. The wood is classed among those that glue satisfactorily with moderate care. It has a good reputation for holding paint.

**Uses.**—A large proportion of the annual output of cottonwood is cut into lumber and veneer and then remanufactured into containers and furniture. Both lumber and veneer are used in the furniture industry for core material, which is overlaid with high-grade furniture veneers.

**Description.**—Heartwood of all three cottonwood species is grayish white to light grayish brown with occasional streaks of light brown. The annual rings are rather wide. Pores are barely visible on smooth cut, end-grain surfaces. Aside from the color of the heartwood, cottonwood is extremely similar to black willow. Separation of the two species is based mainly on heartwood color, which is light brown or reddish brown in willow, or on microscopic examination if only sapwood material is available. (*Illustration, p. 19.*)



American beech

American sycamore

Rock elm

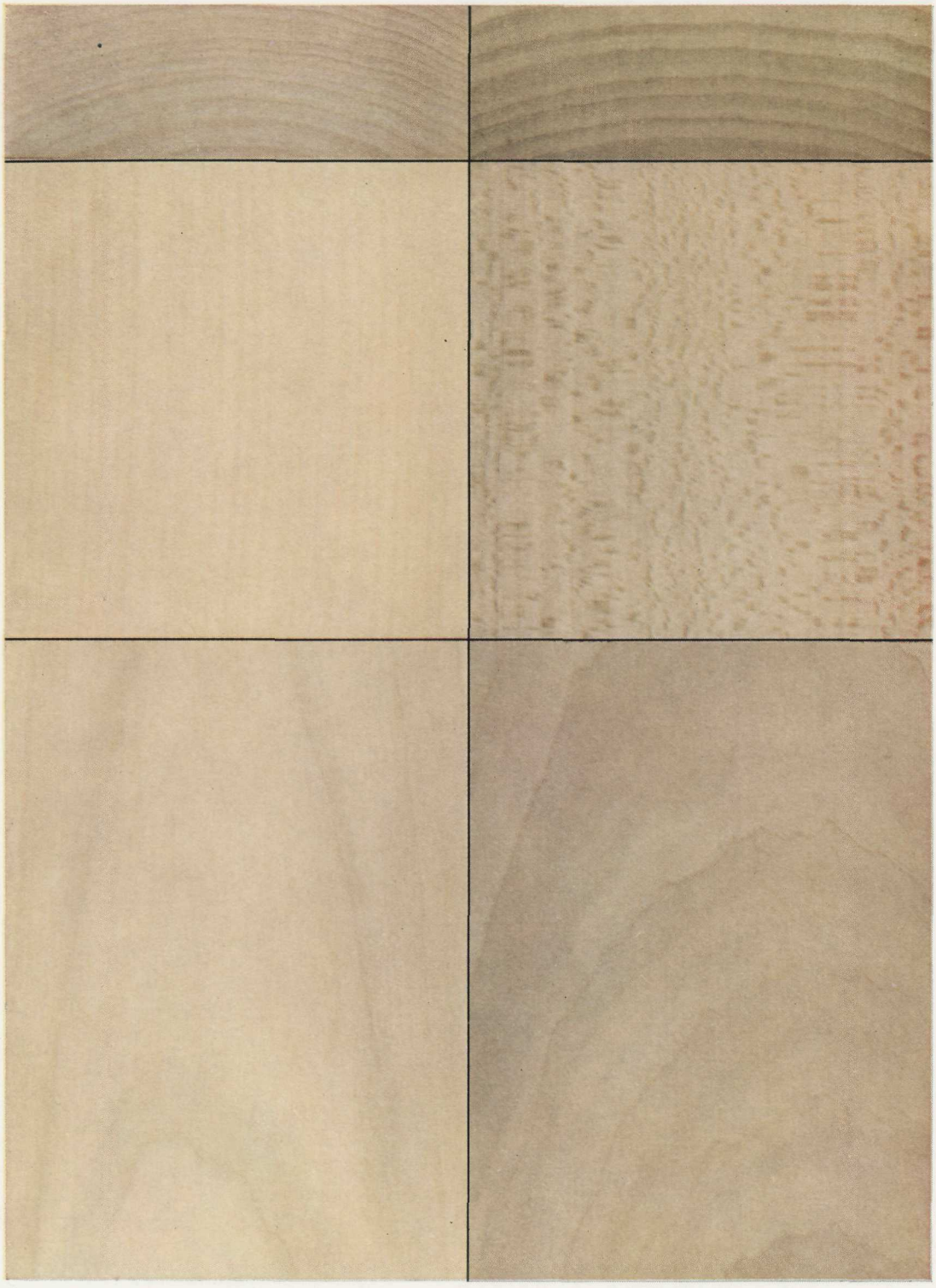
American elm

Black walnut

Black cherry

True hickory

White ash



Quaking aspen

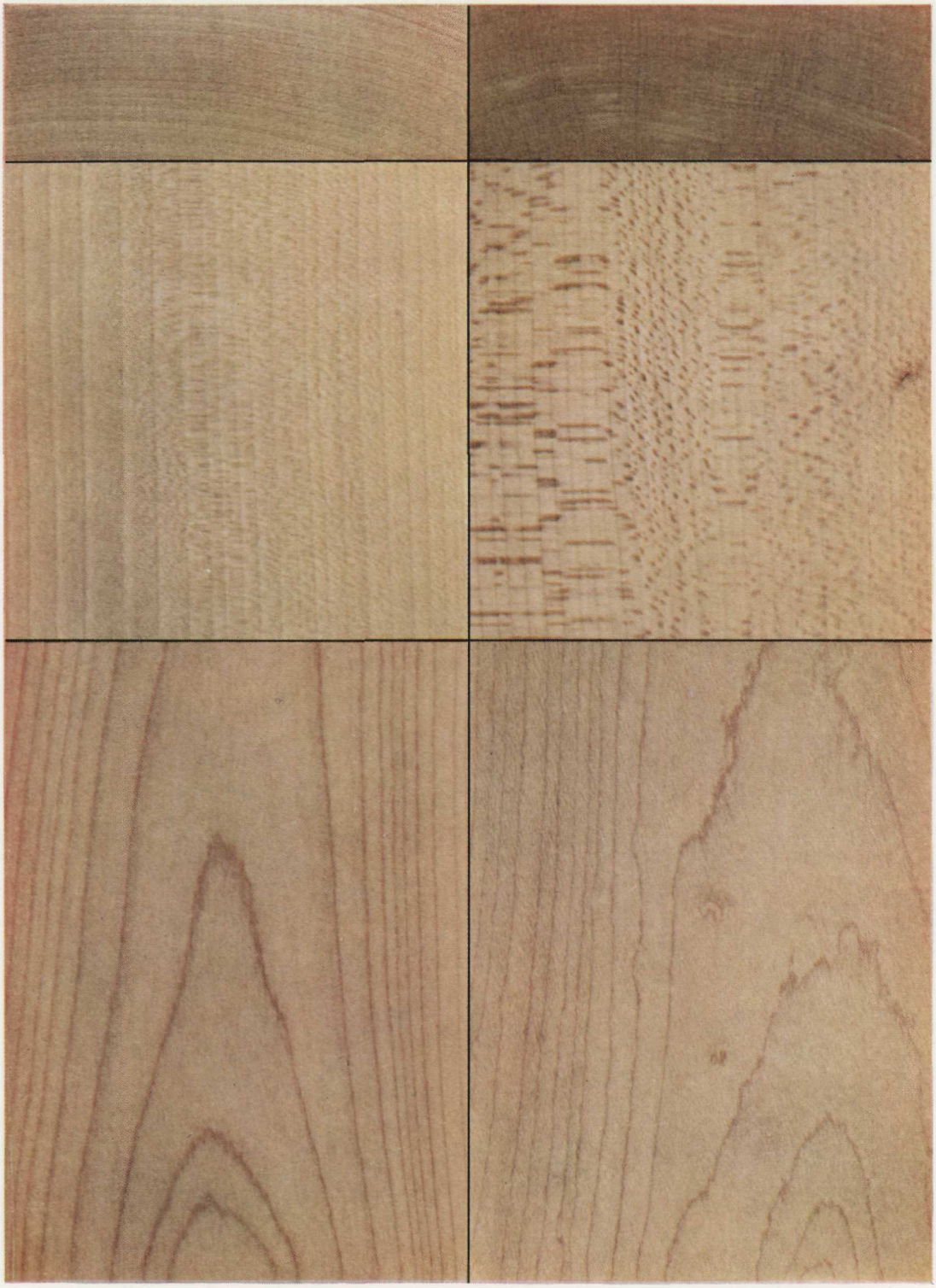
Basswood

Sweetgum

Black tupelo

White oak

Red oak



Yellow birch

Sugar maple

Yellow-poplar

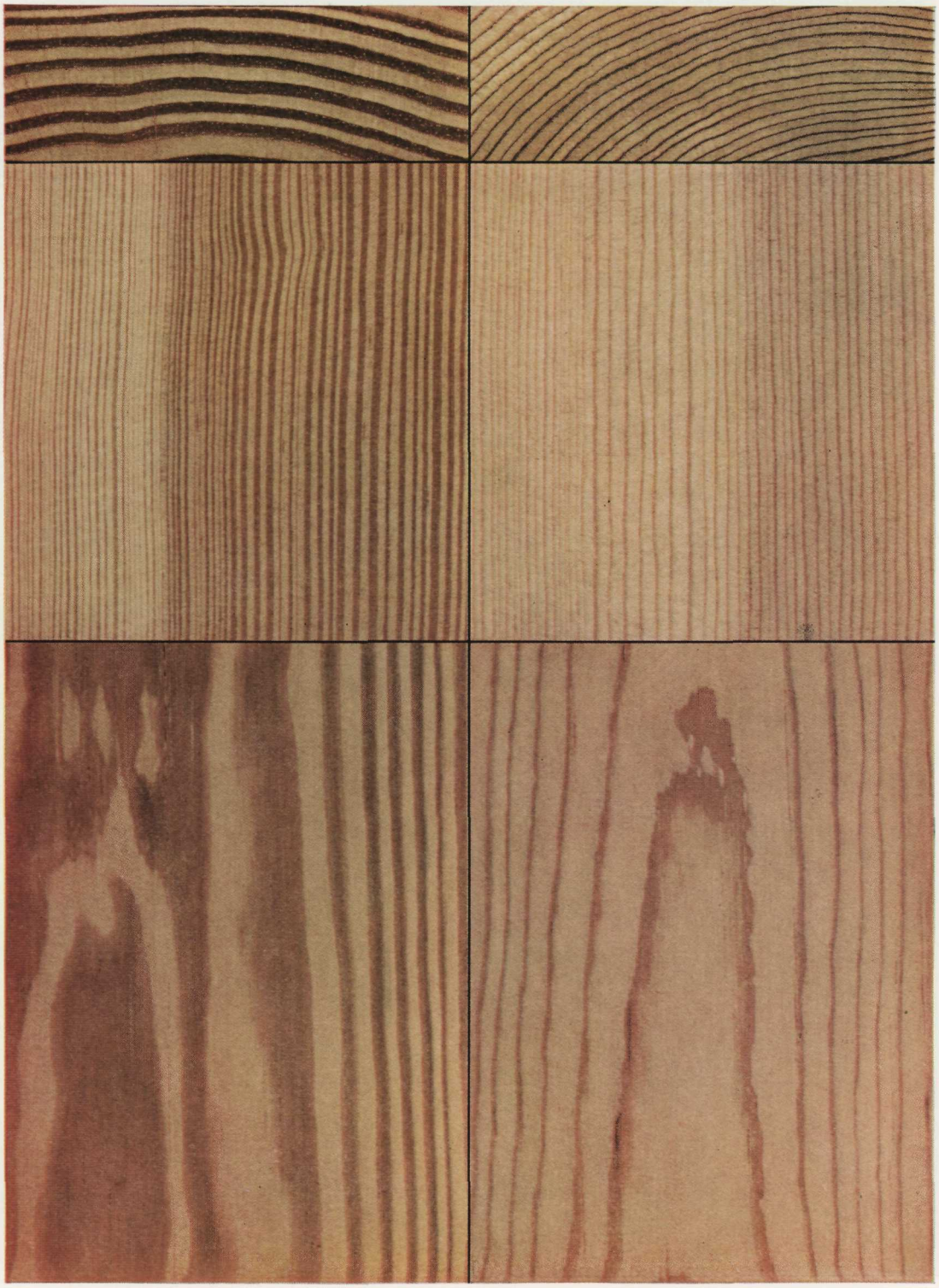
Cottonwood

Baldcypress

Redwood

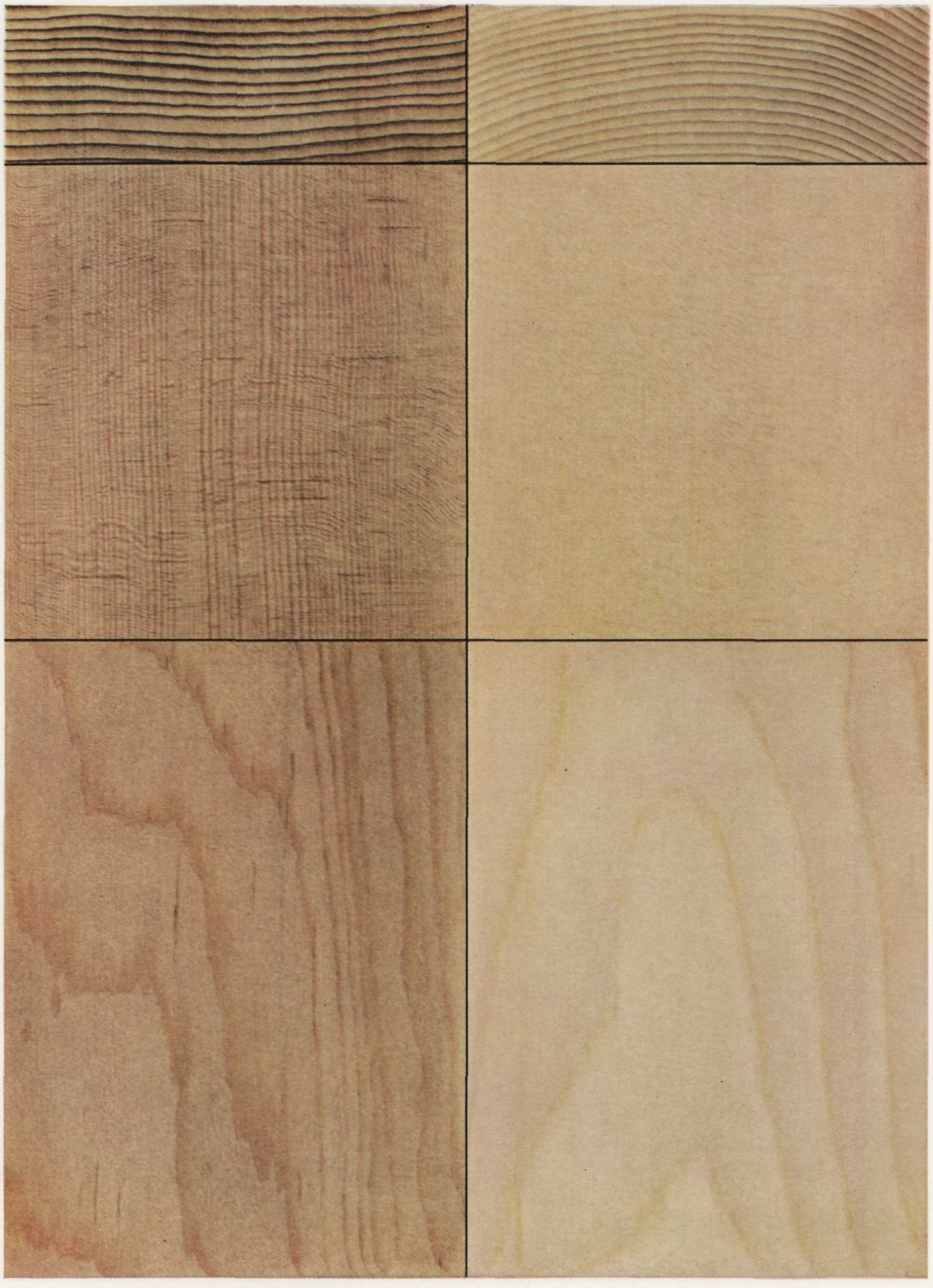
Incense-cedar

Western redcedar



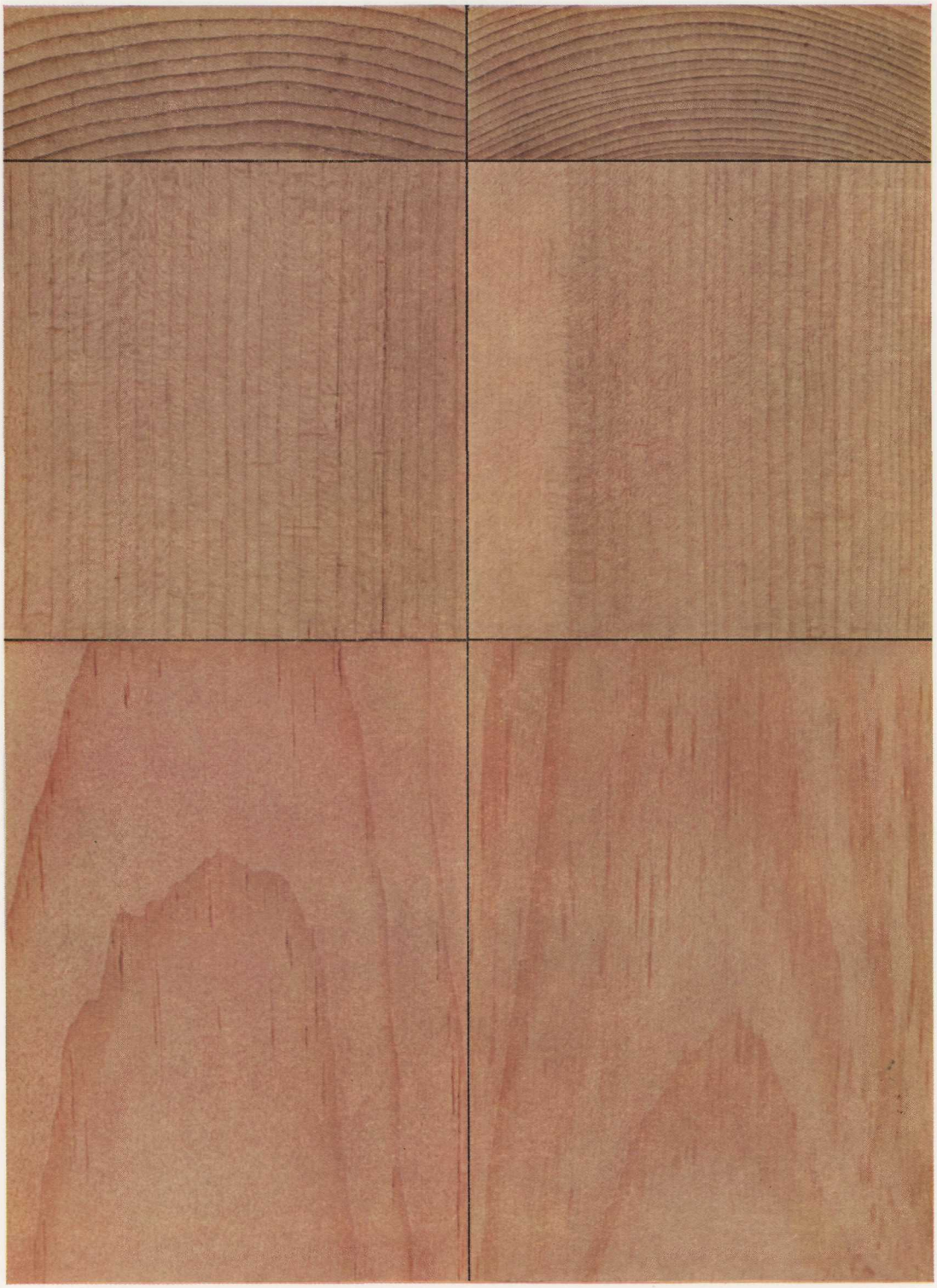
Shortleaf pine

Ponderosa pine



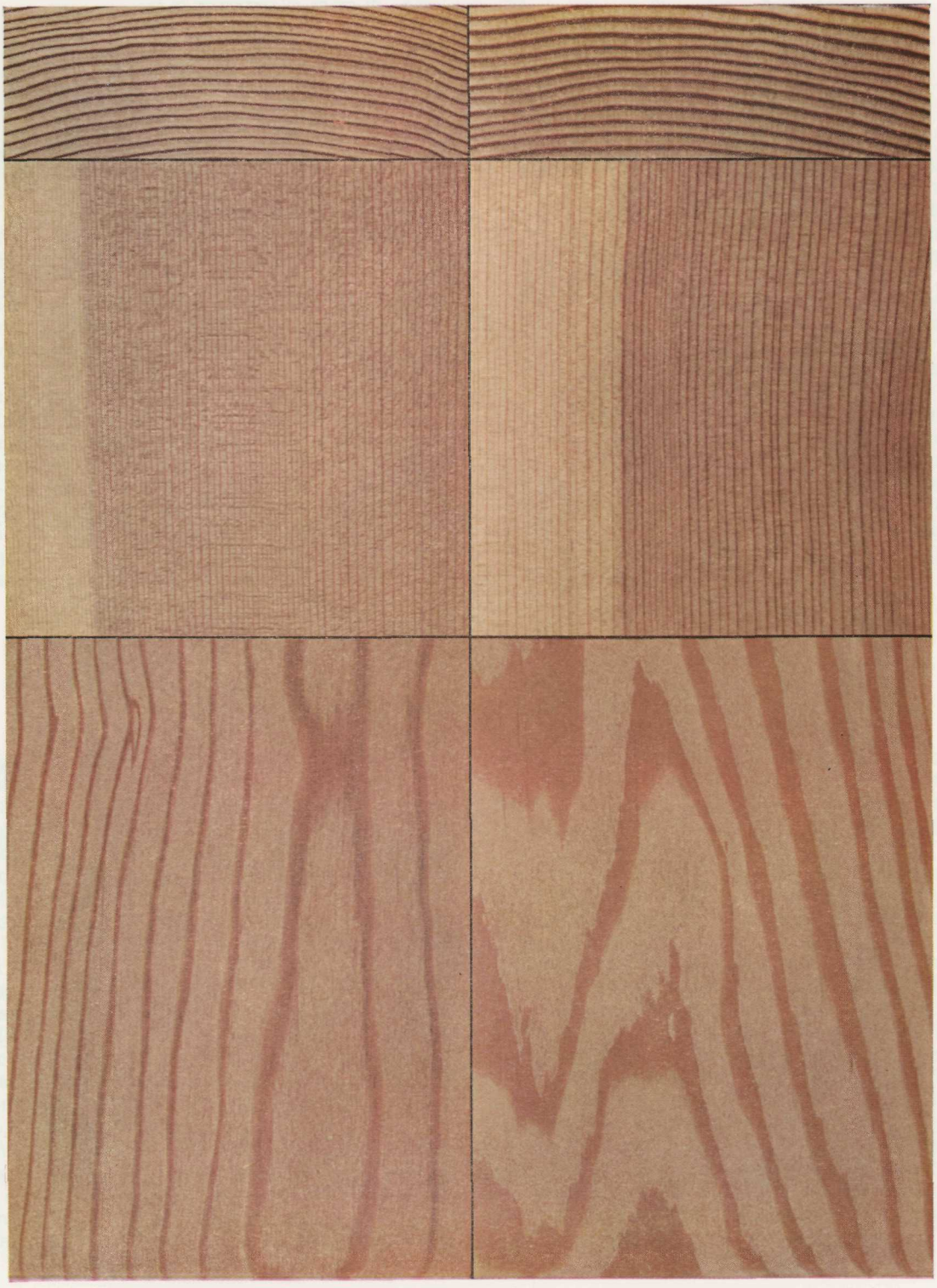
Sitka spruce

Engelmann spruce



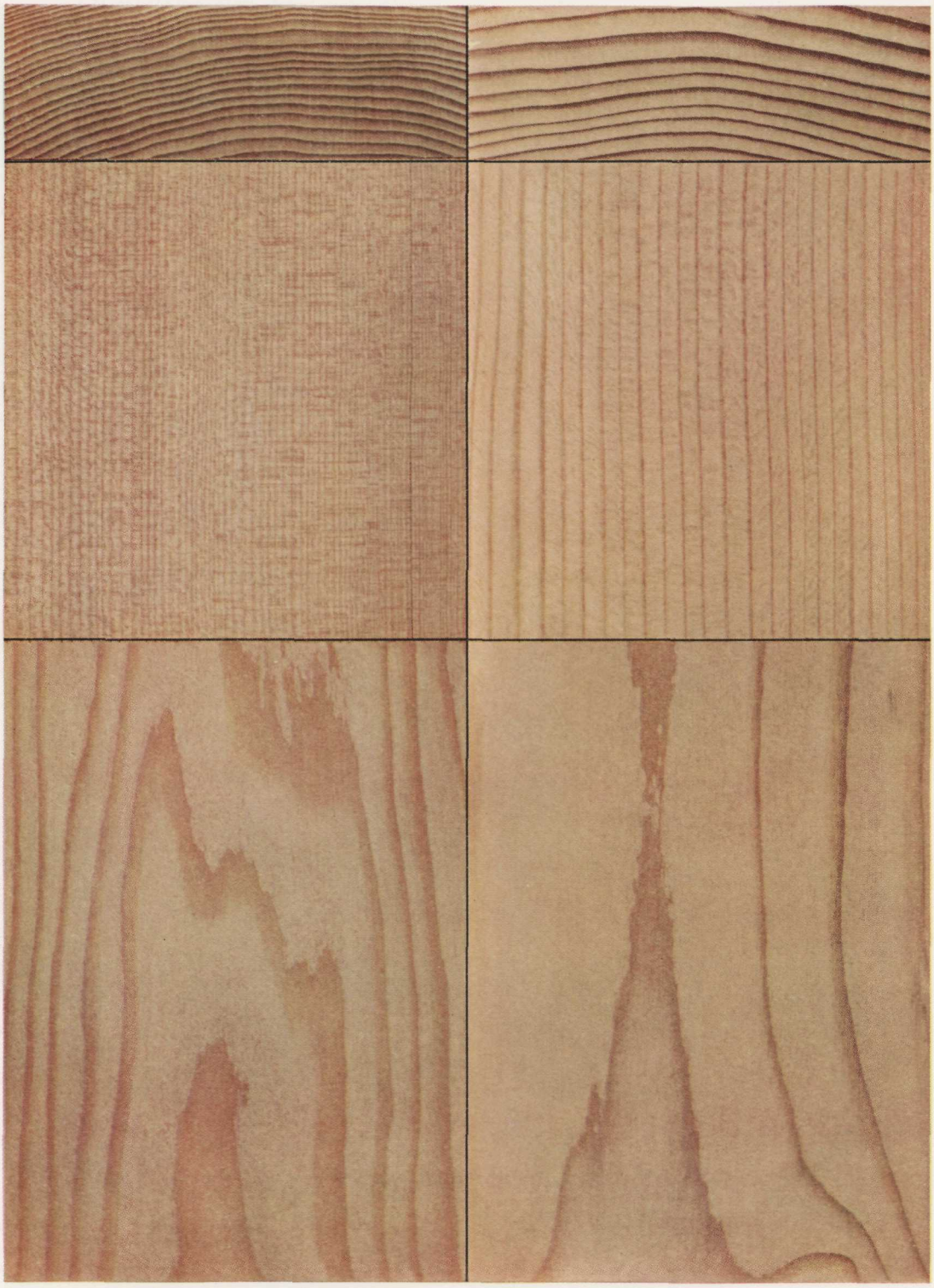
Sugar pine

Western white pine



Western larch

Douglas-fir



Western hemlock

White fir

# SOFTWOODS (Cone-Bearing Species)

## Baldcypress (*Taxodium distichum*)

**Range.**—Baldcypress grows along the Atlantic Coastal Plain from Delaware to Florida and westward along the gulf coast nearly to the Mexican border in Texas and up the Mississippi Valley to southern Indiana. The heaviest stands occur in the swamps of the lower Mississippi Valley and Florida.

**Properties.**—Baldcypress is moderately heavy, with an average weight of 32 pounds a cubic foot, and moderately hard, with a specific gravity of 0.42. The wood is also moderately strong and moderately stiff. Its durability under conditions favorable to decay is outstanding.

Since green baldcypress lumber contains considerable moisture, it requires more care and time to kiln-dry than many other softwoods. However, the wood has moderately small shrinkage and slow air-drying is successfully practiced. It does not impart taste, odor, or color to food products.

**Uses.**—The principal use of baldcypress is in building construction, especially where decay resistance is required. It is frequently used for posts, beams, and other members in warehouses, docks, factories, and bridges. Because of its high degree of resistance to decay, it is particularly valuable for greenhouses, stadium seats, cooling towers, and roof planks of dye houses.

Cypress is also used extensively for caskets and burial boxes and for sash, doors, blinds, interior trim and paneling, and general millwork. Containers, such as boxes, crates, vats, tanks, and tubs, require considerable quantities.

**Description.**—Heartwood varies in color from pale brown to blackish brown and sometimes has a reddish tinge. The wood is without resin canals, and transition from springwood to summerwood is abrupt, as in redwood. Heartwood of darker specimens generally has a more or less rancid odor and longitudinal surfaces feel distinctly greasy or waxy. (*Illustration, p. 20.*)

## Redwood (*Sequoia sempervirens*)

**Range.**—Redwood grows along or near the coast of California in a narrow, irregular strip not more than 35 miles wide and about 500 miles long, extending from 100 miles south of San Francisco to a little above the Oregon border. This massive tree does not grow naturally outside this area, which is characterized by frequent fogs and considerable soil moisture. Single acres of redwood have been found that contained over 1 million board-feet of lumber.

**Properties.**—Typical virgin-growth redwood is moderately light in weight, averaging 28 pounds a cubic foot. The wood is moderately hard, with a specific gravity of 0.38, moderately strong, and moderately stiff. Except for shock resistance, it has somewhat higher strength properties for its weight than would be expected.

Redwood is thought to owe its outstanding decay resistance to the reddish extractive in the tree, which colors the wood and accounts for its name. The wood has very small shrinkage, is comparatively easy to season, and holds its shape well after seasoning. Redwood has only intermediate nail-withdrawal resistance but takes and holds paint exceptionally well. Redwood, the cedars, and baldcypress make up the group of woods with the highest resistance to termites.

**Uses.**—Probably from one-half to two-thirds of the redwood lumber produced is used in the form of planks, dimension, boards, joists, and posts. A large part of this material goes into framing for houses and industrial buildings, and into bridges, trestles, and other heavy construction. Much of the remaining lumber is remanufactured into house siding, sash, blinds, doors, general millwork, outdoor furniture, and tanks. Richly colored redwood paneling provides pleasing interior effects.

**Description.**—Heartwood is usually a uniform deep reddish brown. The wood is without resin canals and has no distinctive odor, taste, or feel. Western redcedar may approach redwood in color, but the distinctive odor of western redcedar separates the two woods immediately. (*Illustration, p. 20.*)

## Incense-cedar (*Libocedrus decurrens*)

**Range.**—Incense-cedar grows from southwestern Oregon southward through California into Mexico and Lower California, with some small stands in western Nevada. Most of the commercial cut is confined to the Sierra Nevada Mountains in California and the mountain regions of northern California and southern Oregon.

**Properties.**—A lightweight wood, incense-cedar averages 26 pounds per cubic foot. The wood is moderately soft, with a specific gravity of 0.35, moderately weak, limber, and low in shock resistance.

Incense-cedar has small shrinkage and is comparatively easy to season with little checking or warping. It ranks among the most decay-resistant woods, along with cypress, redwood, and black locust. Also, the wood splits readily and evenly and is easy to work with tools. Incense-cedar is one of the woods that holds paint longest and suffers least when protection against weathering becomes inadequate.

**Uses.**—The principal uses of incense-cedar are for lumber, fence posts, and crossties. Nearly all the high-grade lumber is used in the manufacture of pencils and venetian blinds. Since most incense-cedar lumber is more or less pecky, it is used locally for rough construction. The qualities of incense-cedar that adapt it particularly to pencil manufacture are straightness of grain, softness, and ease of whittling. Its decay resistance makes it well suited for fence posts and crossties.

**Description.**—Heartwood is reddish brown to dull brown, with an occasional tinge of lavender. Heartwood has a characteristic cedarlike odor and acrid taste. Shavings placed on the tongue for a few seconds give a slight burning sensation. Transition from springwood to summerwood is more or less abrupt and makes the growth rings prominent on flat-grained surfaces. It is easier to produce a smooth cut on the end grain of incense-cedar than on western redcedar. Although incense-cedar and western redcedar cannot always be separated with certainty on the basis of gross features, they can be readily distinguished under the microscope. (*Illustration, p. 21.*)

## Western redcedar (*Thuja plicata*)

**Range.**—Western redcedar grows in a belt along the western coast of North America from southern Alaska to northern California. From northern Washington the range extends as far inland as Montana and then spreads a limited distance north and south on the western slopes of the Rocky Mountains. More than two-thirds of the stand of sawtimber is located in the coast lowlands of Washington.

**Properties.**—Western redcedar is light in weight, averaging 23 pounds a cubic foot. The wood is moderately soft, with a specific gravity of 0.31, weak as a beam or post, moderately limber, and low in ability to resist shock. In decay resistance, the heartwood ranks with the more durable woods.

The wood of western redcedar is not difficult to kiln-dry when proper methods are used, but requires more care in seasoning than other western cedars. After it has been properly dried, it stays in place well and has little tendency to warp. It is comparatively low in nail-withdrawal resistance but can be easily glued. Western redcedar takes and holds paint very well and is exceptionally weather resistant.

**Uses.**—The principal uses of western redcedar are for shingles, lumber, poles, posts, and piling. The lumber goes largely into exterior siding for houses, interior finish, greenhouse construction, flumes, and structural timbers, with smaller amounts being used in the manufacture of ships and boats, caskets, boxes and crating, sash, doors, and general millwork. Round western redcedar poles, most of which are treated with a preservative, are shipped to all parts of the United States for use as utility poles.

**Description.**—Heartwood is reddish or pinkish brown to dull brown. It has a characteristic cedarlike odor, but shavings placed on the tongue do not give quite the sensation that incense-cedar shavings do. Transition from springwood to summerwood is the same as in incense-cedar. The wood is sometimes confused with redwood, but the cedarlike odor of western redcedar separates the two species immediately. (*Illustration, p. 21.*)

## Shortleaf pine (*Pinus echinata*)

**Range.**—Shortleaf pine, which has the widest distribution of the southern pines, grows throughout most of the southeastern United States. It is generally a tree of the uplands and foothills, but its range extends into the lower levels. Stands of shortleaf pine are concentrated in Arkansas, but Texas, Georgia, Alabama, and Mississippi also contain large stands.

**Properties.**—Shortleaf pine, a moderately heavy wood but ranking with the lightest of the important southern pines, has an average weight of 36 pounds a cubic foot. Typically, the wood is moderately hard, with a specific gravity of 0.46, moderately strong, stiff, and moderately shock resistant. The heartwood is moderately decay resistant.

Like all southern pines, shortleaf has moderately large shrinkage but tends to stay in place well after seasoning. In nail-withdrawal resistance, it ranks above hemlock, spruce, and Douglas-fir. And, like other southern pines, it produces a resinous substance from which turpentine and rosin can be made.

**Uses.**—Shortleaf pine lumber is used principally for building material such as interior finish, ceiling, frames, sash, sheathing, subflooring, and joists, and for boxes and crates, caskets, furniture, woodenware, and novelties. Considerable use is also made of shortleaf pine for crossties, telephone and telegraph poles, and mine timbers. In addition, the resin-rich heartwood is distilled to make wood turpentine, tar, and tar oils. Large amounts of this southern pine are used for paper pulp.

**Description.**—Heartwood ranges from shades of yellow and orange to reddish brown or light brown. Transition from springwood to summerwood is abrupt, with the annual rings prominent on all surfaces. Resin canals are large and abundant and are easily found in all annual rings. Summerwood bands are generally wider than those of ponderosa pine. In appearance, the wood of shortleaf pine closely resembles that of longleaf, loblolly, and slash, the other principal southern pines. (*Illustration, p. 22.*)

## Ponderosa pine (*Pinus ponderosa*)

**Range.**—Ponderosa pine grows in every State west of the Great Plains, with the largest stands and greatest commercial production in California, Oregon, and Washington. The tree is found on a wide variety of soils, sites, and elevations and occurs both in pure stands and in mixture with other species. Because it can maintain itself on dry sites, this tree is the principal species on areas of low rainfall.

**Properties.**—The wood of ponderosa pine varies considerably in its properties. However, in the outer portions of trees of sawtimber size, it generally is moderately light in weight, averaging 28 pounds per cubic foot, and moderately soft, with a specific gravity of 0.38. This wood also ranks as moderately weak, moderately limber, and moderately low in shock resistance. It has moderately small shrinkage and little tendency to warp.

Ponderosa pine compares favorably with woods of similar density in nail-withdrawal resistance, is not easily split by nails, and glues easily. The heartwood has low to moderate decay resistance.

**Uses.**—Ponderosa pine is used principally for lumber and, to a lesser extent, for piling, poles, posts, mine timbers, veneer, and hewn ties. The lumber has a variety of uses ranging from high-grade millwork to boxes and crates. For cabinets and millwork, the clearer, softer material is used, while the manufacture of boxes and crates consumes the lower grade lumber. Knotty ponderosa pine has come into wide use as paneling for interior finish.

**Description.**—Heartwood is yellowish to light reddish or orange brown. Transition from springwood to summerwood is abrupt as in the southern pines, but the summerwood bands are narrow. Growth rings are generally most prominent on the flat-grained surfaces, which also frequently exhibit a dimpled appearance. This appearance is common in lodgepole pine too, but in lodgepole the dimples are smaller and more abundant. The resin canals of ponderosa pine are abundant and easily found in all annual rings. They are larger than those in lodgepole pine, and the heartwood of lodgepole pine is lighter colored than that of ponderosa. (*Illustration, p. 22.*)

## Sitka spruce (*Picea sitchensis*)

**Range.**—Sitka spruce grows along the Pacific coast from Alaska to northern California. It is rarely found over 40 miles from the coast and generally grows in mixture with Douglas-fir, grand fir, western hemlock, and western redcedar. It occasionally forms pure stands.

**Properties.**—Sitka spruce is a moderately lightweight wood, averaging 28 pounds a cubic foot. The wood also is moderately soft, with a specific gravity of 0.37, moderately weak in bending and compressive strength, moderately stiff, and moderately low in resistance to shock. On the basis of weight, however, it ranks high in strength properties.

Although the wood has moderately large shrinkage, it is not difficult to kiln-dry. It works easily, holds fastenings well, and can be obtained in clear, straight-grained pieces of large size and uniform texture with hardly any hidden defects. Its decay resistance is low. Although planed surfaces of Sitka spruce lumber may show a silky sheen, the wood has a tendency to produce wooly or fuzzy grain under the action of planer knives. As a pulpwood, Sitka spruce ranks high because of its long, strong fibers and the ease with which it can be pulped by any of the pulping processes.

**Uses.**—Sitka spruce is used principally for lumber, cooperage, and paper pulp. Some of the lumber is used for construction just as it comes from the sawmill, but the greater part is remanufactured into various products. At least half of the remanufactured lumber goes into boxes and crates. The other major uses of the lumber are for furniture, planing-mill products, sash, doors, blinds, and general millwork. Specialty uses include aircraft, ladder rails, and piano sounding boards.

**Description.**—Heartwood is light pinkish yellow to pale brown. Transition from springwood to summerwood is gradual, making the annual rings appear rather inconspicuous on flat-grained surfaces. Resin canals are usually more prominent than in the other spruces. On end-grain surfaces, the canals appear as small dots or very short lines that run parallel to the growth ring. Flat-grained surfaces are lustrous and frequently exhibit dimpling. The pinkish color of the heartwood distinguishes this species from all other spruces. (*Illustration, p. 23.*)

## Engelmann spruce (*Picea engelmannii*)

**Range.**—In the United States, Engelmann spruce grows along the upper slopes of the Cascade Mountains in Washington, Oregon, and the extreme northern part of California, and in the Rocky Mountains in northeastern Washington, northeastern Oregon, Idaho, Montana, Wyoming, Colorado, Utah, Arizona, and New Mexico. The largest producers of Engelmann spruce are Colorado, Montana, and Idaho.

**Properties.**—Engelmann spruce is rated as light in weight, averaging 24 pounds a cubic foot. The wood is soft, with a specific gravity of 0.32, and is weak as a beam or post, moderately limber, and low in ability to resist shock.

Engelmann spruce can be readily air-dried with little tendency to warp. It has moderately small shrinkage and stays in place well when properly dried. The wood is low in decay resistance but glues easily under a wide range of gluing conditions. Engelmann space has excellent pulping and papermaking properties.

**Uses.**—Engelmann spruce is used principally for lumber and to a lesser extent for mine timbers, crossties, and poles. A large proportion of the lumber goes into building construction and boxes. Much of it is used for subflooring, sheathing, and studding. Some Engelmann spruce is pulped for paper.

**Description.**—Heartwood is not distinct from sapwood and ranges from nearly white to pale yellowish brown. Transition from springwood to summerwood is somewhat more abrupt than in the other spruces. Resin canals are present, but are frequently difficult to find. They appear on very smoothly cut, end-grain sections as small white dots and on longitudinal surfaces as short, light-brown streaks or very fine grooves. The wood of all the spruces, with the exception of Sitka, is very similar in its gross and microscopic features and therefore almost impossible to tell apart. (*Illustration, p. 23.*)

## Sugar pine (*Pinus lambertiana*)

**Range.**—Sugar pine grows from the Coast and Cascade Mountain Ranges of southern Oregon, along the Coast Range and the Sierra Nevada of California, through southern California in scattered stands, and into Mexico. The heaviest stands and largest trees are found in California from Tulare to Eldorado Counties, in cool, moist sites on the west slope of the Sierra Nevada at elevations of 4,000 to 7,000 feet.

**Properties.**—Sugar pine is lightweight, averaging 25 pounds a cubic foot. The wood is moderately soft, with a specific gravity of 0.35, moderately limber, moderately weak, and low in shock resistance.

In decay resistance, sugar pine heartwood is rated low to moderate. The wood has very small shrinkage, seasons readily without checking or warping, and stays in place well. It is easy to work with tools, does not split easily in nailing, and has moderate nail-withdrawal resistance.

**Uses.**—Sugar pine is used almost entirely for lumber in buildings, boxes and crates, sash, doors, frames, general millwork, and foundry patterns. It is suitable for all phases of house construction, with the high-grade material going into interior and exterior trim, siding, and paneling, while the lower grade material is used for sheathing, subflooring, and roof boards.

The wood also has proved very satisfactory for containers because of its light weight and color, nailing properties, and freedom from taste and odor. Sugar pine is widely used for foundry patterns because it meets the exacting requirements and is readily available in wide, thick pieces practically free from defects.

**Description.**—Heartwood is light brown to pale reddish brown. Resin canals are abundant and commonly stain the surface of the wood with resin. Transition from springwood to summerwood is gradual; making the growth rings appear less prominent on flat-grained surfaces. (*Illustration, p. 24.*)

## Western white pine (*Pinus monticola*)

**Range.**—Western white pine grows from the Canadian border southward into western Montana and northern Idaho, and along the Cascade and Sierra Nevada Mountains through Washington and Oregon to central California. The heaviest stands occur in northern Idaho and in adjacent parts of Montana and Washington. The trees usually grow in mixture with western hemlock, western redcedar, western larch, grand fir, and Douglas-fir, but occasionally occur in pure stands on limited areas.

**Properties.**—Moderately light in weight, western white pine averages 27 pounds a cubic foot. The wood is moderately soft, with a specific gravity of 0.36, weak, moderately stiff, and moderately low in ability to resist shock.

Although the wood has moderately large shrinkage, it is easy to kiln-dry and stays in place well after seasoning. In decay resistance, it is ranked as low to moderate. Western white pine works easily with tools and glues readily. It does not split easily in nailing and occupies an intermediate position in nail-withdrawal resistance.

**Uses.**—Practically all of the western white pine cut is sawed into lumber. About three-fourths of this lumber is used in building construction. The lower grades are used for subflooring and wall and roof sheathing, while the high-grade material is made into siding of various kinds, exterior and interior trim, partition, casing, base, and paneling. Other uses of western white pine include match planks, boxes, and millwork products.

**Description.**—Heartwood is cream colored to light brown or reddish brown. Resin canals are abundant and transition from springwood to summerwood is like that in sugar pine. Separation of western white pine and sugar pine is generally accomplished on the basis of the resin canals, which are larger in sugar pine than in the other white pines. Microscopic characteristics, however, offer a more reliable means of differentiation than gross features. (*Illustration, p. 24.*)

## Western larch (*Larix occidentalis*)

**Range.**—Western larch grows in mountain valleys and on slopes at elevations of 2,000 to 7,000 feet in Washington, Oregon, western Montana, and northern Idaho. It reaches its best development and greatest commercial importance in northern Idaho and western Montana, where it is generally associated with other species, although sometimes forming pure forests of limited extent.

**Properties.**—A heavy wood, western larch has an average weight of 38 pounds per cubic foot. Also, it is moderately hard, with a specific gravity of 0.51, stiff, strong, and moderately high in shock resistance.

Western larch and Douglas-fir are frequently logged together and sold in mixture under the commercial name of "larch-fir." Heartwood of both species is moderately decay resistant. Western larch has large shrinkage in drying and presents seasoning problems because of the slowness with which it gives up its moisture. Although it ranks high in nail-withdrawal resistance, small or blunt-pointed nails are preferred to reduce splitting.

**Uses.**—Western larch is used principally in building construction as rough dimension, small timbers, planks, and boards. Considerable amounts also are made into crossties and mine timbers. Probably three-fourths of the lumber produced is used for structural purposes as it comes from the sawmill. Some of the high-grade lumber is remanufactured into interior finish, flooring, sash, doors, blinds, and other products.

**Description.**—Heartwood is russet brown and the color is best seen in summerwood bands on flat-grained surfaces. Resin canals are present, but are very small and difficult to find unless the resin has stained the wood surfaces or the exudation actually appears as very small droplets. Transition from springwood to summerwood is abrupt and there is little difference in color between the two zones. The heartwood lacks a distinctive odor. (*Illustration, p. 25.*)

## Douglas-fir (*Pseudotsuga menziesii*)

**Range.**—In the United States, Douglas-fir grows in most forests from the Rocky Mountains to the Pacific coast and from the Mexican to Canadian borders. Botanically it is not a true fir. It reaches its largest size and fastest rate of growth in Washington and Oregon, where large trees form very dense forests that sometimes yield as much as 100,000 board-feet of lumber per acre.

**Properties.**—Most old-growth Douglas-fir from the Pacific coast and northern Rocky Mountain States is moderately heavy, very stiff, moderately strong, and moderately shock resistant. It averages about 33 pounds a cubic foot. The wood is also moderately hard, with an average specific gravity ranging from 0.40 to 0.48. Wide-ringed second-growth Douglas-fir from the coastal States and material grown in the southern Rocky Mountain States tends to be lighter in weight and to have lower strength properties.

The wood of Douglas-fir can be readily kiln-dried if proper methods are used. Although it is more difficult to work with handtools than the soft pines, it holds fastenings well and can be glued satisfactorily. Dense heartwood has moderate decay resistance.

**Uses.**—The principal uses of Douglas-fir are for lumber, timbers, piling, and plywood. Remanufactured lumber goes mostly into sash, doors, general millwork, railroad car construction and repair, and boxes and crates. Plywood is now in wide use for sheathing, concrete forms, prefabricated house panels, millwork, ships and boats, and other structural forms. Chipped Douglas-fir sawmill residue has a considerable market at pulp mills.

**Description.**—Heartwood is orange red to red or sometimes yellowish. Resin canals, which are seen as brownish streaks in the summerwood, appear to be more abundant and more readily detectable than in western larch. Transition from springwood to summerwood is similar to that in western larch. The heartwood of Douglas-fir may be confused with that of the southern yellow pines, but resin canals are larger and much more abundant in southern pines. Most Douglas-fir has a distinctive odor. (*Illustration, p. 25.*)

## Western hemlock (*Tsuga heterophylla*)

**Range.**—Western hemlock grows along the Pacific coast from Alaska to San Francisco Bay, and as far inland as northern Idaho and northwestern Montana. The best stands are found in the humid coastal regions of Oregon, Washington, and Alaska and on the lower slopes of the Cascade Mountains in Washington and Oregon.

**Properties.**—Western hemlock is moderately light in weight, averaging 29 pounds a cubic foot, and moderately hard, with a specific gravity of 0.38. It is also moderately weak and its shock resistance is fairly low. Although western hemlock has moderately large shrinkage, it is comparatively easy to season. Heartwood is low in decay resistance but the wood is easy to work with tools and has satisfactory gluing properties. Excellent for papermaking, it yields a tough, strong, and easily bleached pulp.

**Uses.**—Western hemlock is used primarily for pulpwood and construction lumber and, to a limited extent, for containers, plywood core stock, crossties, and mine timbers. The pulp is used for newsprint and other printing paper, tissues, wrapping papers, and viscose and other cellulose derivatives. Although little western hemlock goes into heavy structural material, large quantities are used for sheathing, siding, subflooring, joists, studding, planking, and rafters in light frame construction.

**Description.**—Heartwood of western hemlock is light reddish brown and frequently has a purplish cast, especially in the summerwood bands. Transition from springwood to summerwood is gradual and on end-grain surfaces there is little color contrast between the two zones. The wood lacks normal resin canals.

Eastern hemlock heartwood is more roseate in color than western hemlock and the transition from springwood to summerwood is so abrupt that the two zones stand out distinctly. The coarser texture of eastern hemlock springwood tends to tear out in crosscut sawing and to produce a ribbed appearance on the end grain. A smooth cut is difficult to make on the end grain of eastern hemlock, even with a very sharp knife, while western hemlock cuts very easily and produces smooth surfaces. (*Illustration, p. 26.*)

## White Fir (*Abies*)

**Species names.**—White fir (*Abies concolor*), grand fir (*A. grandis*), Pacific silver fir (*A. amabilis*), California red fir (*A. magnifica*), and noble fir (*A. procera*).

**Range.**—Commercial white fir, which includes all the above species, grows throughout the Pacific Coast and Rocky Mountain States. The largest stands of white fir (*A. concolor*) probably occur in California, but other States contain larger stands of the other species.

**Properties.**—Commercial white fir is light in weight, the various species ranging from 26 to 28 pounds a cubic foot. It is moderately soft, with an average specific gravity of 0.35, moderately weak, moderately low in shock resistance, moderately stiff, and low in nail-withdrawal resistance. It is difficult to season, a fact that retarded its use until satisfactory seasoning methods were developed. Also, its decay resistance is low, but gluing properties are satisfactory. White fir produces strong, high-quality paper pulp.

**Uses.**—White fir is used principally for lumber and pulpwood. The lumber goes largely into building construction, planing-mill products, boxes and crates, sash, doors, frames, and general millwork. Probably 75 percent or more of all white fir lumber is used for framing, subflooring, and sheathing of houses. Pulpwood is used chiefly in the manufacture of various grades of printing paper and high-grade wrapping paper.

**Description.**—Heartwood is nearly white to pale reddish brown and the wood lacks normal resin canals. Transition from springwood, like that in eastern hemlock, is more abrupt than in western hemlock. Also, color of springwood and summerwood on end-grain surfaces is more contrasting than in western hemlock. The balsam fir of the east is more uniformly white in color, with less contrasting rings than the western firs. Wood rays of the western firs frequently contain colored material that makes them stand out more on edge-grained surfaces than rays of the eastern firs, which are generally colorless. (*Illustration, p. 26.*)

# GLOSSARY

*Annual growth ring.*—The growth layer put on in a single growth year, including springwood and summerwood.

*Bark.*—Outer layer of a tree, comprising the inner bark, or thin, inner living part (phloem) and the outer bark, or corky layer, composed of dry, dead tissue.

*Beam.*—A structural member supporting a load applied transversely to it.

*Bending, steam.*—The process of forming curved wood members by steaming or boiling the wood and bending it to a form.

*Bird's-eye.*—Small localized areas in wood with the fibers indented and otherwise contorted to form few to many small circular or elliptical figures remotely resembling birds' eyes on the tangential surface. Common in sugar maple and used for decorative purposes; rare in other hardwood species.

*Bow.*—The distortion in a board that deviates from flatness lengthwise but not across its faces.

*Broad-leaved trees.*—(See *Hardwoods.*)

*Cambium.*—The one-cell-thick layer of tissue between the bark and wood that repeatedly subdivides to form new wood and bark cells.

*Cell.*—A general term for the minute units of wood structure, including wood fibers, vessels members, and other elements of diverse structure and function.

*Check.*—A lengthwise separation of the wood, usually extending across the rings of annual growth and commonly resulting from stresses set up in the wood during seasoning.

*Collapse.*—The flattening of groups of cells in heartwood during the drying or pressure treatment of wood, characterized by a caved-in or corrugated appearance.

*Crook.*—The distortion in a board that deviates edgewise from a straight line from end to end of the board.

*Cup.*—The distortion in a board that deviates flatwise from a straight line across the width of the board.

*Decay.*—The decomposition of wood substance by fungi.

*Advanced (or typical) decay.*—The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent.

*Incipient decay.*—The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

*Density.*—The weight of a body per unit volume. When expressed in the c. g. s. (centimeter-gram-second) system, it is numerically equal to the specific gravity of the same substance.

*Diffuse-porous wood.*—Certain hardwoods in which the pores tend to be uniform in size and distribution throughout each annual ring or to decrease in size slightly and gradually toward the outer border of the ring.

*Dimension.*—(See *Lumber.*)

*Dimension stock.*—A term largely superseded by the term hardwood dimension lumber. It is hardwood stock processed to a point where the maximum waste is left at a dimension mill, and the maximum utility is delivered to the user. It is stock of specified thickness, width, and length, in multiples thereof. According to specification, it may be solid or glued; rough or surfaced; semifabricated or completely fabricated.

*Dimensional stabilization.*—Reduction through special treatment in swelling and shrinking of wood, caused by changes in its moisture content with changes in relative humidity.

*Dry kiln.*—(See *Kiln.*)

*Dry rot.*—A term loosely applied to any dry, crumbly rot but especially to that which, when in an advanced stage, permits the wood to be crushed easily to a dry powder. The term is actually a misnomer, since all wood-rotting fungi require considerable moisture for growth.

*Early wood.*—(See *Springwood.*)

*Edge-grained.*—(See *Grain.*)

*Extractives.*—Substances in wood, not an integral part of the cellular structure, that can be removed by solution in hot or cold water, ether, benzene, or other solvents that do not react chemically with wood components.

*Fiber, wood.*—A comparatively long (one twenty-fifth or less to one-third inch), narrow, tapering wood cell closed at both ends.

*Figure.*—The pattern produced in a wood surface by annual growth rings, rays, knots, deviations from regular grain such as interlocked and wavy grain, and irregular coloration.

*Finish.*—Wood products to be used in the joiner work, such as doors and stairs, and other fine work required to complete a building, especially the interior.

*Flakes.*—(See *Rays, wood.*)

*Flat-grained.*—(See *Grain.*)

*Framing.*—Lumber used for the structural members of a building, such as studs and joists.

*Girder.*—A large or principal beam used to support concentrated loads at points along its length.

*Grade.*—The designation of quality of a manufactured piece of wood or of logs.

*Grain.*—The direction, size, arrangement, appearance, or quality of the elements in wood or lumber. To have a specific meaning the term must be qualified.

*Close-grained wood.*—Wood with narrow, inconspicuous annual rings. The term is sometimes used to designate wood having small and closely spaced pores, but in this sense the term "fine textured" is more often used.

*Coarse-grained wood.*—Wood with wide conspicuous annual rings in which there is considerable difference between springwood and summerwood. The term is sometimes used to designate wood with large pores, such as oak, ash, chestnut, and walnut, but in this sense the term "coarse textured" is more often used.

*Cross-grained wood.*—Wood in which the fibers deviate from a line parallel to the sides of the piece. Cross grain may be either diagonal or spiral grain, or a combination of the two.

*Curly-grained wood.*—Wood in which the fibers are distorted so that they have a curled appearance, as in "bird's-eye" wood. The areas showing curly grain may vary up to several inches in diameter.

*Diagonal-grained wood.*—Wood in which the annual rings are at an angle with the axis of a piece as a result of sawing at an angle with the bark of the tree or log. A form of cross grain.

*Edge-grained lumber.*—Lumber that has been sawed so that the wide surfaces extend approximately at right angles to the annual growth rings. Lumber is considered edge grained when the rings form an angle of 45° to 90° with the wide surface of the piece.

*Fine-grained wood.*—(See *Grain, close-grained wood.*)

*Flat-grained lumber.*—Lumber that has been sawed so the wide surfaces extend approximately parallel to the annual growth rings. Lumber is considered flat grained when the annual growth rings make an angle of less than 45° with the surface of the piece.

*Grain*—Continued

*Interlocked-grained wood.*—Wood in which the fibers are inclined in one direction in a number of rings of annual growth, then gradually reverse and are inclined in an opposite direction in succeeding growth rings, then reverse again.

*Open-grained wood.*—Common classification by painters for woods with large pores, such as oak, ash, chestnut, and walnut. Also known as "coarse textured."

*Plainsawed lumber.*—Another term for flat-grained lumber.

*Quartersawed lumber.*—Another term for edge-grained lumber.

*Spiral-grained wood.*—Wood in which the fibers take a spiral course about the trunk of a tree instead of the normal vertical course. The spiral may extend in a right-handed or left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

*Straight-grained wood.*—Wood in which the fibers run parallel to the axis of a piece.

*Vertical-grained lumber.*—Another term for edge-grained lumber.

*Wavy-grained wood.*—Wood in which the fibers collectively take the form of waves or undulations.

*Green.*—Freshly sawed lumber, or lumber that has received no intentional drying; unseasoned. The term does not apply to lumber that may have become completely wet through waterlogging.

*Hardwoods.*—Generally, the botanical group of trees that have broad leaves, in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood.

*Heartwood.*—The wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may be infiltrated with gums, resins, and other materials that usually make it darker and more decay resistant than sapwood.

*Honeycombing.*—Checks, often not visible at the surface, that occur in the interior of a piece of wood, usually along the wood rays.

*Joint.*—The junction of two pieces of wood or veneer.

*Joist.*—One of a series of parallel beams used to support floor and ceiling loads and supported in turn by larger beams, girders, or bearing walls.

*Kiln.*—A heated chamber for drying lumber, veneer, and other wood products.

*Knot.*—That portion of a branch or limb which has been surrounded by subsequent growth of the wood of the trunk or other portion of the tree. As a knot appears on the sawed surface, it is merely a section of the entire knot, its shape depending upon the direction of the cut.

*Longitudinal.*—Generally, the direction along the length of the grain of wood.

*Lumber.*—The product of the saw and planing mill, not further manufactured than by sawing, resawing, passing lengthwise through a standard planing machine, cross-cutting to length, and matching.

*Boards.*—Yard lumber less than 2 inches thick and 1 or more inches wide.

*Dimension.*—Lumber from 2 inches to, but not including 5 inches thick, and 2 or more inches wide.

*Dressed size.*—The dimensions of lumber after shrinking from the green dimensions and being surfaced with a planing machine to usually ⅜ or ½ inch less than the nominal or rough size. For example, a 2- by 4-inch stud actually measures 1⅝ by 3⅝ inches under American lumber standards for softwood lumber.

*Nominal size.*—As applied to timber or lumber, the rough-sawed commercial size by which it is known and sold in the market.

*Structural lumber.*—Lumber that is 2 or more inches thick and 4 or more inches wide, intended for use where working stresses are required. The grading of structural lumber is based on the strength of the piece and the use of the entire piece.

*Timbers.*—Lumber 5 or more inches in least dimension. Timbers may be classified as beams, stringers, posts, caps, sills, girders, purlins, etc.

*Medullary rays.*—(See *Rays, wood.*)

*Millwork.*—Generally, all building materials made of finished wood and manufactured in millwork plants and planing mills. Includes such items as inside and outside doors, window and door frames, blinds, porch work, mantels, panel work, stairways, moldings, and interior trim. Does not include flooring, ceiling, or siding.

*Moisture content of wood.*—The amount of water contained in the wood. Usually expressed as a percentage of the weight of the ovendry wood.

*Naval stores.*—A term applied to the oils, resins, tars, and pitches derived from oleoresin contained in, exuded by, or extracted from trees chiefly of the pine species (genus *Pinus*) or from the wood of such trees.

*Old growth.*—Timber growing in or harvested from a mature, naturally established forest. When the trees have grown most or all of their individual lives in active competition with their companions for sunlight and moisture, this timber is usually straight and relatively free of knots.

*Ovendry wood.* Wood dried to constant weight in an oven at temperatures above that of boiling water (usually 101° to 105° C. or 214° to 221° F.).

*Peck.*—Pockets or areas of disintegrated wood caused by advanced stages of localized decay in the living tree. It is usually associated with cypress and incense-cedar. There is no further development of peck once the lumber is seasoned.

*Pitch pocket.*—An opening that extends parallel to the annual growth rings and that contains, or has contained, either solid or liquid pitch.

*Pitch streak.*—A well-defined accumulation of pitch in a more or less regular streak in the wood of certain softwoods.

*Pith.*—The small, soft core occurring in the structural center of a tree trunk, branch, twig, or log.

*Plainsawed.*—(See *Grain.*)

*Planing-mill products.*—Products worked to pattern, such as flooring, ceiling, and siding.

*Plywood.*—An assembly made of layers (plies) of veneer, or of veneer in combination with a lumber core, joined with an adhesive. The grain of adjoining plies is usually laid at right angles, and almost always an odd number of plies are used to obtain balanced construction.

*Pore.*—(See *Vessels.*)

*Porous woods.*—Another name for hardwoods, which frequently have vessels or pores large enough to be seen readily without magnification.

*Preservative.*—Any substance that is effective, for a reasonable length of time, in preventing the development and action of wood-rotting fungi, borers of various kinds, and harmful insects that deteriorate wood.

*Quartersawed.*—(See *Grain.*)

*Radial.*—Coincident with a radius from the axis of the tree or log to the circumference. A radial section is a lengthwise section in a plane that extends from pith to bark.

*Rate of growth.*—The rate at which a tree has laid on wood, measured radially in the trunk or in lumber cut from the trunk. The unit of measure in use is number of annual growth rings per inch.

*Rays, wood.*—Strips of cells extending radially within a tree and varying in height from a few cells in some species to 4 or more inches in oak. The rays serve primarily to store food and transport it horizontally in the tree.

*Resin passage (or duct).*—Intercellular passages that contain and transmit resinous materials. On a cut surface, they are usually inconspicuous. They may extend vertically parallel to the axis of the tree or at right angles to the axis and parallel to the rays.

*Ring-porous woods.*—A group of hardwoods in which the pores are comparatively large at the beginning of each annual ring and decrease in size more or less abruptly toward the outer portion of the ring, thus forming a distinct inner zone of pores, known as the springwood, and an outer zone with smaller pores, known as the summerwood.

*Sap.*—All the fluids in a tree except special secretions and excretions, such as oleoresin.

*Sapwood.*—The living wood of pale color near the outside of the log. Under most conditions the sapwood is more susceptible to decay than heartwood.

*Seasoning.*—Removing moisture from green wood in order to improve its serviceability.

*Air-dried.*—Dried by exposure to air, usually in a yard, without artificial heat.

*Kiln-dried.*—Dried in a kiln with the use of artificial heat.

*Second growth.*—Timber that has grown after removal by cutting, fire, wind, or other agency, of all or a large part of the previous stand.

*Sheathing.*—The structural covering, usually of boards or fiberboards, placed over exterior studding or rafters of a structure.

*Softwoods.*—Generally, the botanical group of trees that bear cones and in most cases have needlelike or scalelike leaves; also the wood produced by such trees. The term has no reference to the actual hardness of the wood.

*Specific gravity.*—The radio of the weight of a body to the weight of an equal volume of water at 4° C. or other specified temperature.

*Springwood.*—The portion of the annual growth ring that is formed during the early part of the season's growth. In most softwoods and in ring-porous hardwoods, it is less dense and weaker mechanically than summerwood.

*Stain.*—A discoloration in wood that may be caused by such diverse agencies as micro-organisms, metal, or chemicals. The term also applies to materials used to color wood.

*Strength.*—The term in its broader sense includes all the properties of wood that enable it to resist different forces or loads. In its more restricted sense, strength may apply to any one of the mechanical properties, in which event the name of the property under consideration should be stated, thus: strength in compression parallel to grain, strength in bending, hardness, and so on.

*Stress.*—Force per unit of area.

*Stud.*—One of a series of slender wood structural members used as supporting elements in walls and partitions.

*Summerwood.*—The portion of the annual growth ring that is formed after the springwood formation has ceased. In most softwoods and in ring-porous hardwoods, it is denser and stronger mechanically than springwood.

*Tangential.*—Strictly, coincident with a tangent at the circumference of a tree or log, or parallel to such a tangent. In practice, however, it often means roughly coincident with a growth ring. A tangential section is a longitudinal section through a tree or limb and is perpendicular to a radius. Flat-grained and plainsawed lumber is sawed tengentially.

*Texture.*—A term often used interchangeably with grain. Sometimes used to combine the concepts of density and degree of contrast between springwood and summerwood. In this publication, texture refers to the finer structure of the wood (see *Grain*) rather than the annual rings.

*Twist.*—A distortion caused by the turning or winding of the edges of a board so that the four corners of any face are no longer in the same plane.

*Tyloses.*—Masses of cells appearing somewhat like froth in the pores of some hardwoods, notably white oak and black locust. In hardwoods, tyloses are formed when walls of living cells surrounding vessels extend into the vessels. They are sometimes formed in softwoods in a similar manner by the extension of cell walls into resin-passage cavities.

*Veneer.*—A thin layer or sheet of wood cut on a veneer machine.

*Rotary-cut veneer.*—Veneer cut in a lathe which rotates a log or bolt, chucked in the center, against a knife.

*Sawed veneer.*—Veneer produced by sawing.

*Sliced veneer.*—Veneer that is sliced off a log, bolt, or flitch with a knife.

*Vertical grain.*—(See *Grain.*)

*Vessels.*—Wood cells of comparatively large diameter that have open ends and are set one above the other so as to form continuous tubes. The openings of the vessels on the surface of a piece of wood are usually referred to as pores.

*Virgin growth.*—The original growth of mature trees.

*Wane.*—Bark or lack of wood from any cause on the edge or corner of a piece of lumber.

*Warp.*—Any variation from a true or plane surface. Warp includes bow, crook, cup, and twist, or any combination thereof.

*Weathering.*—The mechanical or chemical disintegration and discoloration of the surface of wood that is caused by exposure to light, the action of dust and sand carried by winds, and the alternate shrinking and swelling of the surface fibers with the continual variation in moisture content brought by changes in the weather. Weathering does not include decay.

*Wood substance.*—The solid material of which wood is composed. It usually refers to the extractive-free solid substance of which the cell walls are composed, but this is not always true. There is no wide variation in chemical composition or specific gravity between the wood substance of various species; the characteristic differences of species are largely due to differences in infiltrated materials and variations in relative amounts of cell walls and cell cavities.

*Workability.*—The degree of ease and smoothness of cut obtainable with hand or machine tools.



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